A Third CITATION

FOR THE INSTRUMENT LEADER

. . . FOR MERITORIOUS WAR PRODUCTION

This third citation for meritorious war production . . climaxing a long record of war service . . . is a source of justifiable pride to the men and women of WESTON.

The record began back in the earliest days of our defense period, when a large segment of WESTONS' capacity was assigned to the production of instruments vital to military needs. Thus, when we finally were forced into this world struggle, WESTON was ready for *full-scale war production.*

This new star which adorns our "E" pennant marks the *third* time WESTON has been *first* in this highly specialized field to receive each successive war citation. Weston Electrical Instrument Corporation, Newark 5, New Jersey.

Laboratory Standards . . . Precision DC and AC Portables . . . Instrument Transformers . . . Sensitive Relays . . . DC, AC, and Thermo Switchboard and Panel Instruments.

WESTON

Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters . . . Aircraft Instruments . . . Electric Tachometers . . . Dial Thermometers.

FOR OVER 35 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

Electrical World

FOUNDED IN 1874 • READ BY ELECTRICAL MEN FOR 69 YEARS

April 29, 1944 — Vol. 121, No. 18

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330 West 42nd Street, New York 18, N. Y.
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Please change my address on Electrical World

From .....

.....

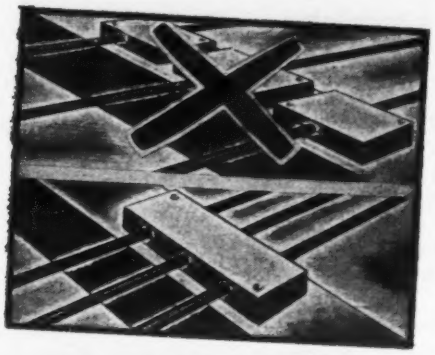
To .....

.....

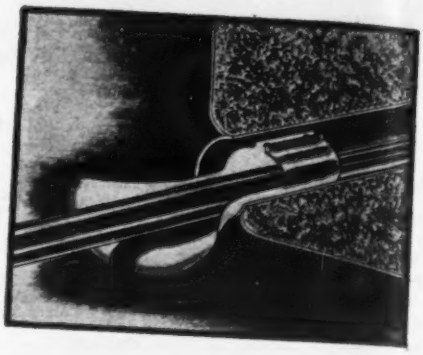
Signed .....

DAMAGE

A few easily-observed rules will help prevent damage to electric wires, cables and cords from abrasion, mechanical abuse, and other sources of trouble. Here are some helpful hints:



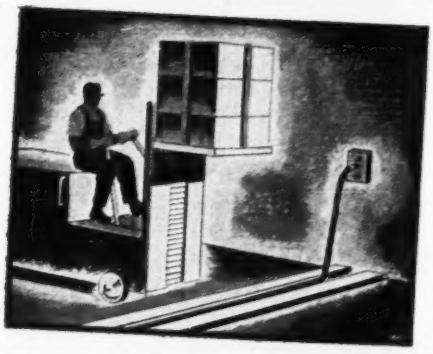
SPACE YOUR CABLES AS CLOSE TOGETHER AS POSSIBLE on overhead circuits if you need to reduce reactive voltage drop. Leave space for air circulation. Indoors, keep cables away from high voltage equipment and sparking motors. They generate ozone which is destructive to rubber.



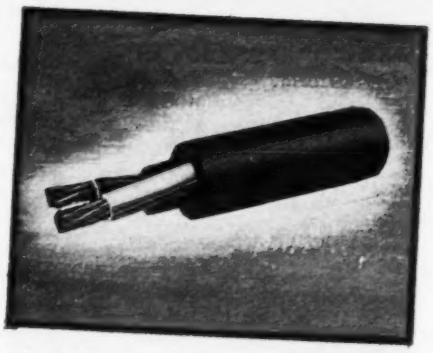
WHERE WEAR MAY OCCUR, such as in duct mouths, protect your cables with a semi-circular abrasion-resistant sleeve.

SPLICES WILL LAST LONGER when protected by a coating of weatherproof paint.

USE LARGER DIAMETER PULLEYS. Don't run cables and cords over small diameter pulleys or drums. Continued bending and flexing around a short radius breaks the conductors —with a short circuit possibly resulting.



PROTECT CABLES AND CORDS FROM BEING RUN OVER by heavy movable equipment. Don't drag cables around sharp corners or yank them to remove kinks.



SPECIFY THE RIGHT CABLE — Precautions help any cable but remember the added value of using good cables from the start. OKOCORD, for instance, is an unusually sturdy portable cable that takes lots of hard treatment.

We are interested in helping you extend as far as possible the life of your electric cables, cords and wires. Wall chart, OK-2026, in color, with the above and other worthwhile suggestions will be sent on request. The Okonite Company, Passaic, New Jersey.

OKONITE

LITTLE DID WE KNOW, these 12 years while we were saying, "Electroline Automatic Line Splices are reclaimable" that the really big story had not yet been told.

Now this important reclaimable feature scores again. Vital materials from which Automatic Line Splices are made are mostly off to war . . . so it is impossible to supply the quantity of line splices we would like to but your stock bins will supply splices for immediate requirements.

Every "out of service" line equipped with Electroline Automatic Line Splices is a source of supply. These splices are reclaimable.

Electroline Splices can be removed in a jiffy. Back they go to stock bins for re-use . . . time and time again. Stock without stock expenditures. How's that for an "extra" dividend?

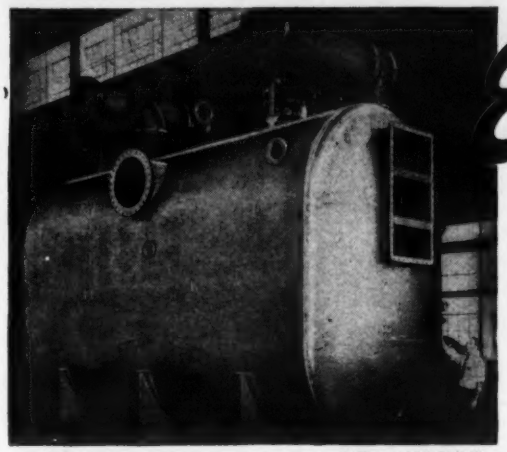
It is the everlasting quality of Electroline products that assures our users of adequate, effective usable Automatic Line Splices for the duration. The quality is there because long experience in this field has taught us how to put it there. Not only the first Automatic Line Splice, but also the first Reclaimable Line Splice came from the house of Electroline.

Electroline Company

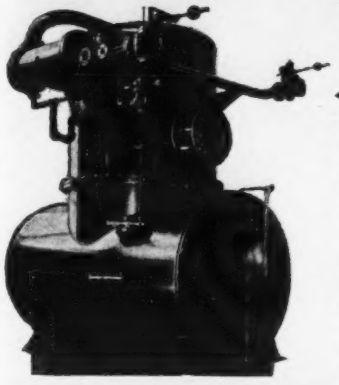
Originators and Patentees of Automatic Line Splices and Dead Ends

4121 SOUTH LA SALLE STREET • CHICAGO 9, ILLINOIS

Elliott engineering gives tailored fit in deaerating heaters!

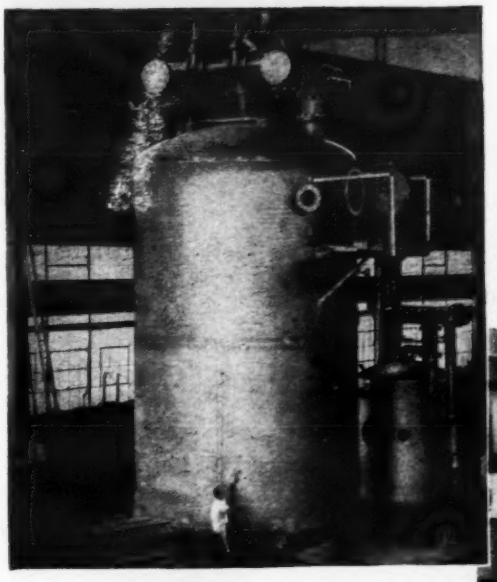


▲This 1,500,000-lb.-per-hr. deaerating heater was shaped to fit into limited width in a big utility station.



◀Typical medium-size vertical deaerating heater mounted on a horizontal storage tank. Vent condenser on side to save headroom.

Two vertical deaerating heaters. Large unit has twice the capacity of the smaller, and eight times the storage capacity. It is up to railroad car limitations—12 ft. by 27 ft. high. ▼



Hardly two deaerating feedwater heater installations are alike in physical characteristics. These units must be fitted to many factors other than the required capacity and operating conditions. The desired amount of storage may mean a large single-shell unit, or a heater with a separate storage tank. Space limitations and available access to buildings must be given first consideration. Railroad clearances limit the size and shape of large units. And with each variation in shape, the critical design areas, volumes, tray and water distribution, piping arrangements, and controls must be proportioned for dependable operation and maximum feedwater heating and deaerating performance.

Obviously you cannot take a standard deaerating heater "off the shelf" and set it to work. It has to be designed, tailored, to fit the conditions. How Elliott engineers fit Elliott deaerating heaters to their jobs is shown in the photos on this page.

●

If you have a heater problem, particularly one that looks tough, talk it over with these Elliott specialists.

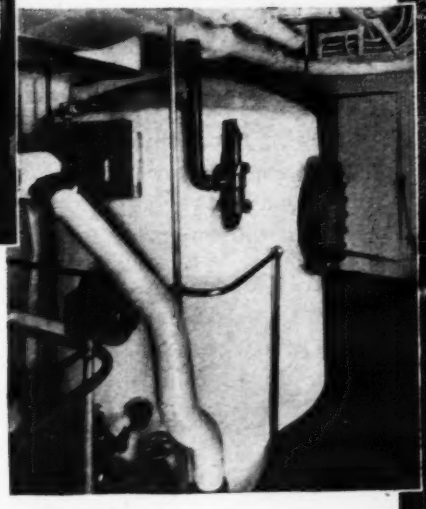
A star has been added to the Army-Navy "E" flags flown by both the Jeannette and the Ridgway plants of Elliott Company.

ELLIOTT COMPANY

Deaerator & Heater Division, **JEANNETTE, PA.**

DISTRICT OFFICES IN PRINCIPAL CITIES

N-975A



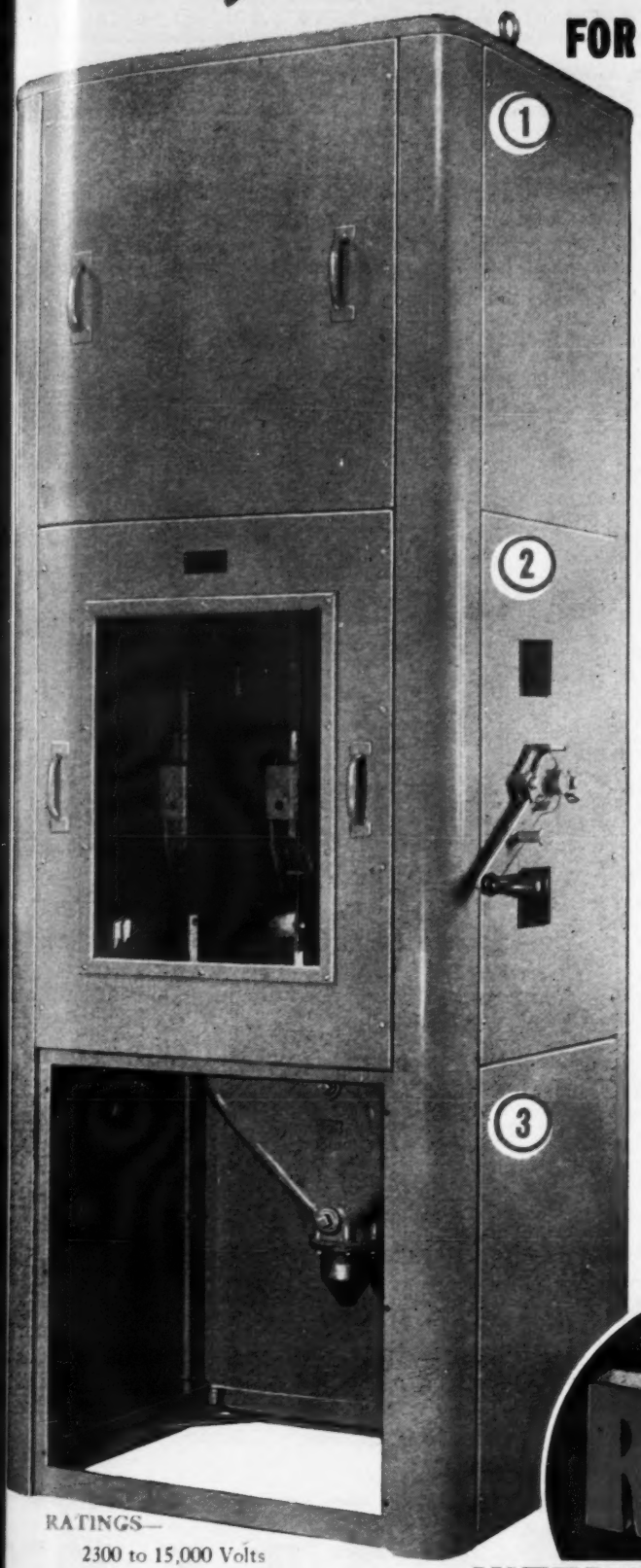
▲

Deaerating heaters for installation on board ship are built with the utmost compactness, usually with internal vent condensers, as illustrated.

For outdoor installation, this Elliott deaerating heater accommodates large water storage underneath the deaerating heater proper. ▶

◀Low headroom deaerating heater, for limited space in existing building. Lower part of unit can be put in place and upper part slid over it. Vent condenser mounted on side.

CHECK the FACTS



FOR YOUR LOAD CENTERS–

specify....

R & I E INTERRUPTER SWITCHES

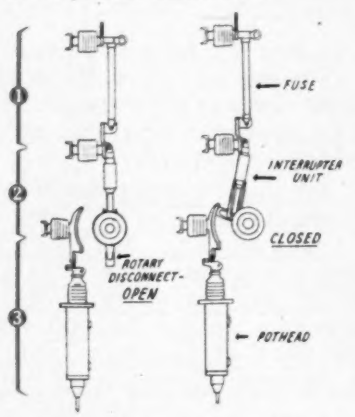
with or without fuses for the primary side

APPLICATIONS—

- In combination with fuses, to provide an economical means of fault protection and isolation for maintenance.
- To isolate transformer banks, instead of oil switches or expensive circuit breakers.
- For transfer or removal of load on energized distribution circuits.
- As a sectionalizing switch in feeder circuits.
- As an ordinary disconnect to provide safety in case of operating error.
- For interrupting exciting load currents of feeder regulators and capacitors.
- For changing transformer connections, star to delta or vice-versa without opening primary feeder.

CONSTRUCTION—

- Sturdy all-welded steel housings.
- All porcelain insulation.
- Floor, wall rack or transformer mounting.
- Available with conduit, through bushing, stud or pothead connections.



Arcs quenched in interrupter unit chamber when current is interrupted — then rotary disconnect establishes open gap.

RATINGS—
2300 to 15,000 Volts
200 and 400 Amperes

R&IE

INTERRUPTER SWITCHES

RAILWAY AND INDUSTRIAL ENGINEERING CO.
GREENSBURG, PA. . . In Canada, Eastern Power Devices, Ltd., Toronto

The Check List

CONDUCTOR SUPPORTS, CLAMPS AND FITTINGS

•

DISCONNECTING SWITCHES
INDOOR AND OUTDOOR

•

AIR BREAK SWITCHES

INTERRUPTER SWITCHES

•

CUTOUTS AND THERMO-RUPTERS

•

SWITCH OPERATING MECHANISMS

•

SUBSTATIONS

•

OPEN OR ENCLOSED, ISOLATED PHASE HEAVY DUTY BUSES

•

KIRK INTERLOCK SYSTEMS

•

AUTOMATIC SECTIONALIZING EQUIPMENT

•

METAL CUBICLES

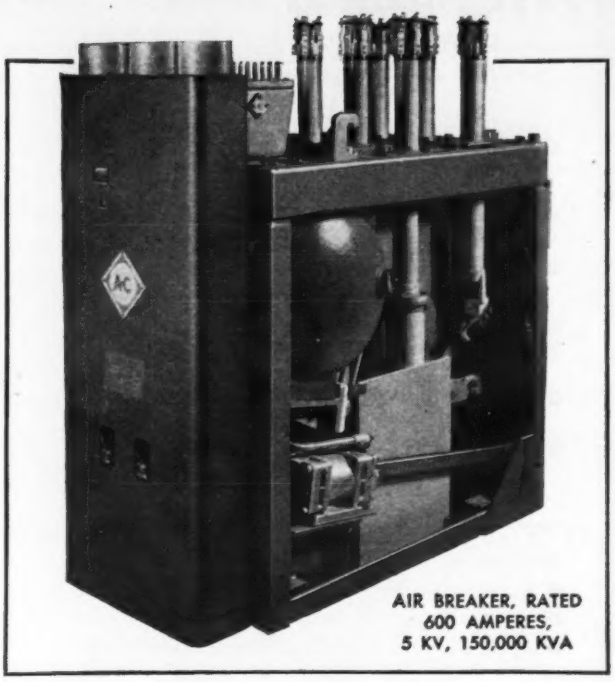
•

TESTING DEVICES

Plan now for Longer

TESTS OF ALLIS-CHALMERS AIR BLAST BREAKER EQUIPPED

APPLICATION, THE ORIGINAL ARCING CONTACTS WILL NOT



AIR BREAKER, RATED 600 AMPERES, 5 KV, 150,000 KVA

☛Up to now it has not been feasible to build power circuit breakers capable of many repetitive fault operations at high currents without maintenance and contact renewal.

But by further development of the inherent characteristics of the axial air blast interrupter, Allis-Chalmers has perfected a breaker that will interrupt scores of faults WITHOUT MAINTENANCE at currents up to 50,000 amperes (over 130 percent of maximum interrupting current rating) in one half cycle or less.

During development and proof-testing of the new breaker and its interrupting device, thousands of tests were made to check its interrupting ability at high integrated duty capacity.

Typical data obtained is shown in a summary of a series of 100 interrupting tests of a 600 ampere, 5 kv, 150,000 kva, 37,500 maximum ampere interrupting capacity breaker. Tests were made with a single set of arcing contacts at currents ranging from 10,000 to 41,000 rms amperes. All tests were made at or below rated minimum air blast pressure. . .

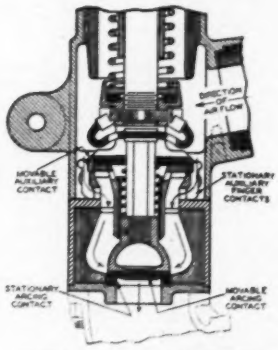
No. of Shots	RMS Current Interrupted, Amps.	Duty	Arcing Time Cycles
30	10,000-15,000	CO	0.05 to 0.4
21	15,000-20,000	CO	0.04 to 0.4
15	20,000-25,000	CO	0.05 to 0.6
21	25,000-30,000	CO	0.05 to 0.7
4	30,000-35,000	CO	0.1 to 0.45
9	35,000-41,000	CO	0.1 to 0.55

Oscillograms showed that peak inrush currents closed on some of these tests were as high as 115,000 amperes.

Isolating contacts repeatedly closed against peak inrush currents up to maximum current obtained without appreciable burning . . . indicating that hundreds of high current closures without maintenance can be expected.

Schematic diagram of a single pole of the new breaker is shown at right. Main electrical circuit is from T_1 downward through arcing and auxiliary contacts L and M, up through shell B, through isolating contacts D, and up to T_2.

Air blast circuit is from tank through blast valve A and manifold K to contact chamber B . . . through orifice contact M, interrupting chamber W, and exhaust tube C.



DESIGN OF INTERRUPTER.

☛Superior performance of new interrupter is mainly result of high degree of limitation and control of arc energy and arc products during and immediately after arc inception.

ALLIS

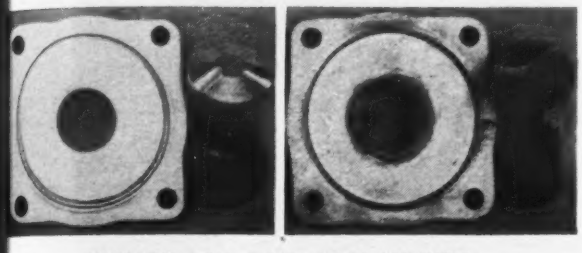
Breaker Contact Life!

WITH IMPROVED INTERRUPTER IMPLY THAT, ON AN AVERAGE HAVE TO BE REPLACED DURING THE LIFE OF THE BREAKER!

Separate arcing and disconnecting contacts connected in series separate the interrupting and isolating functions . . . to permit each contact to be designed only for its specific function.

Arcing contact has a short stroke which helps keep initial arc energy low . . . and provides for effective air blast and proper arc propagation.

Arrangement and high operating speed of isolating disconnect contacts permit closing of high currents in air WITH NEGLIGIBLE DETERIORATION OF THE CONTACTS.



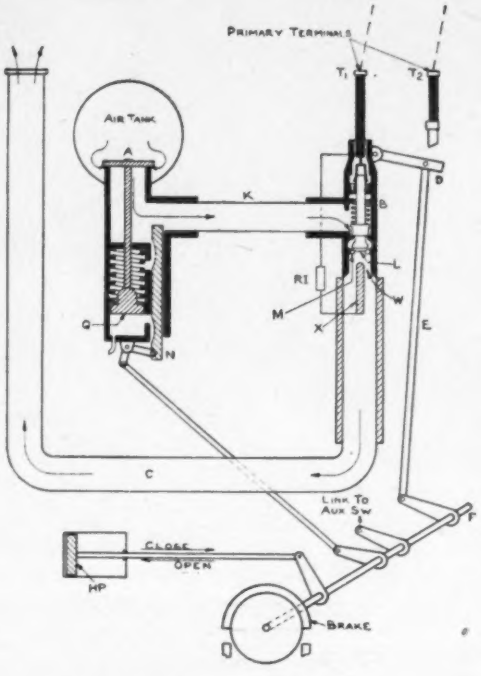
CONTACTS BEFORE AND AFTER 100 TESTS.

Location of the isolating contacts completely apart from the interrupting unit permits absolute isolation of the circuit—eliminating hazards of shunting leakage surfaces.

Overall design of new breaker results in maximum of control over minimum of arc energy.

And—new air blast breaker is comparable in size and shape to common frame indoor oil circuit breaker of same rating! Note, above left, compactness of new small size air blast breaker, rated 600 amperes, 5 kv, 150,000 kva.

☛Look for other important new developments in power and electrical equipment from Allis-Chalmers. Maybe we can help you—maybe you can help us. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 1721



Schematic Diagram

A — Air blast valve. When opened compressed air flows through K to contact chamber B — opens arcing contacts L — flows through contact M interrupting chamber W and exhaust tube C.

B — Contact chamber.

C — Exhaust tube.

D — Disconnect (or isolator) contact — opens after L is open.

E — Insulated operating links.

F — Breaker shaft — operated by air piston Hp — connected to disconnect D, auxiliary switches, and slide valve N.

Hp — Disconnect operating piston — operates shaft F, disconnects D, auxiliary switches, and slide valve N.

K — Air distribution manifold.

L — Movable arcing contact — blown open by air blast — spring reclosed after D opens.

M — Stationary arcing contact.

N — Slide valve — operated from shaft F — when D reaches "open" position valve vents air on bottom of Q to atmosphere and admits air from K to top of Q to close A and shut off air blast.

T_1 — Primary terminals — primary circuit is through T_1, L, M, B, D to T_2.

Q — Blast valve piston — operates blast valve A.

R1 — Non-inductive resistor — controls recovery voltage transient.

W — Interrupting chamber.

X — Resistor electrode.

CHALMERS

♪ Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, EWT.

"O.K.–Nope–O.K.–O.K.–"

TO WATCH HIM operate, you'd think Walter Conner of Allis-Chalmers Norwood Works was conducting a one-man scrap drive.

Not that he finds many defective motor shafts in the course of a day's inspection — but he sure *looks* for them. And when he finds one — bang — it lands on a scrap pile.

In a way, it's the group of motors we *didn't* build that's behind the reputation: "You can depend on Allis-Chalmers Motors!"

But actually, building consistently great motors requires far more than rejecting parts and assemblies that don't come up to Allis-Chalmers standards . . . because there are dozens of points in every motor that *can't be tested* by known methods or instruments.

How can you test the honesty and skill with which a rotor end connection was silver-brazed in depth . . . a hidden coil assembled?

You *can't.*

That's why we're glad Allis-Chalmers craftsmen know today — as they've known for years—that they have a big personal stake in every motor they build for you.

They know that when they build great motors they're making *friends* . . . and that no company and its workers can have too many of them.

Next time you need the kind of extra-quality (but not extra-price) motors Allis-Chalmers builds, check with our nearby district office. Or write direct to ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

• • •

♪ *Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, EWT.*

AC WE WORK FOR VICTORY WE PLAN FOR PEACE

A 1727

YOU CAN DEPEND ON ALLIS-CHALMERS MOTORS

O-B LINE POSTS NEVER CHANGE

BECAUSE THEIR VITAL INNER CHAMBER IS SEALED IN CHANGELESS PORCELAIN

Post type insulators are just as good as their seal--and no better! Any moisture that can ever be drawn into the inner chamber will result in serious deterioration of a unit's dielectric and radio values...In the O-B line post, this seal is proved for its soundness by a prolonged vacuum holding test and its permanence is assured by use of a glazed-in porcelain barrier. Time, temperature, or any other operating condition can have no effect on the O-B ceramic seal...If your design requirements call for post insulators, specify O-B Line Posts whose all-porcelain construction makes their original electrical characteristics lasting and un-changeable as porcelain itself.

Ohio Brass

MANSFIELD, OHIO, U.S.A.

CANADIAN OHIO BRASS CO., LTD., NIAGARA FALLS, ONTARIO

2473-H

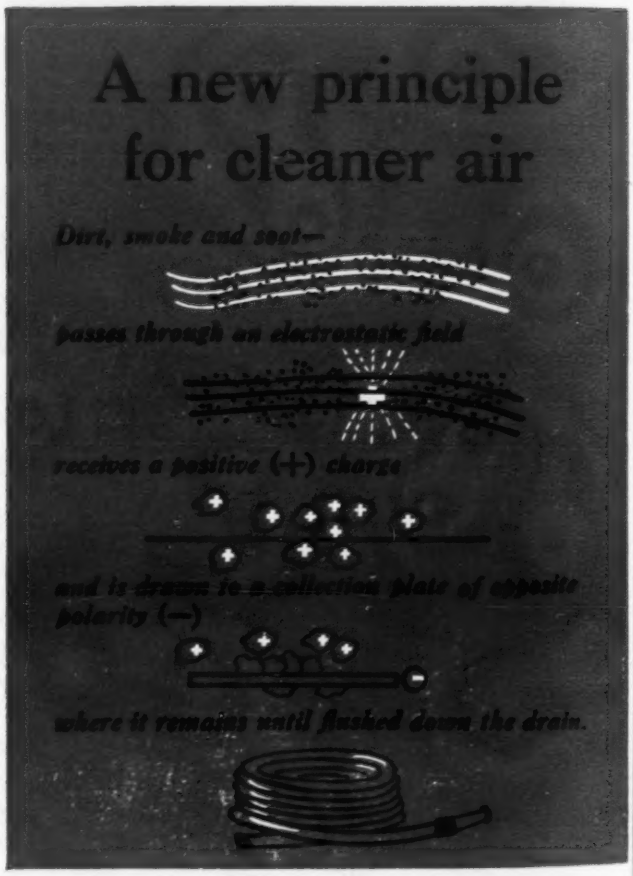
air. . .may be costing you plenty!

The air in your plant may be costing you plenty. Air-borne particles, 100 times smaller than the eye can see, cause shutdowns, ruin products, contaminate atmospheres and reduce the efficiency of your employees.

Conventional air cleaners can't remove these microscopic particles. But Westinghouse PRECIPITRON, cleaning air electrostatically, traps particles as small as 1/250,000 of an inch . . . even removes haze, welding fumes, tobacco smoke.

Really clean air is vital to production . . . to good working conditions and good health. Check the advantages of PRECIPITRON now . . . for war production or for early postwar uses in other fields. Westinghouse Electric & Mfg. Co., Dept. 7-N, East Pittsburgh, Pa.

J-04002


A new principle for cleaner air
Dirt, smoke and soot—
passes through an electrostatic field
receives a positive (+) charge
and is drawn to a collection plate of opposite polarity (—)
where it remains until flushed down the drain.

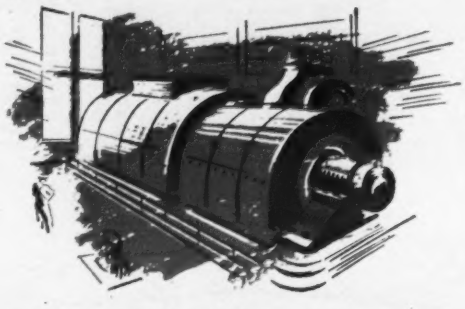
Westinghouse Precipitron

PLANTS IN 25 CITIES OFFICES EVERYWHERE

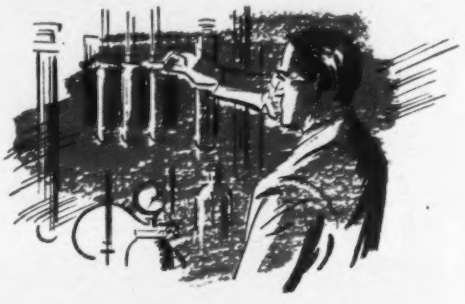
Precipitron *Applications*

MACHINERY & PRECISION INSTRUMENT PLANTS . . . Precipitron sweeps the air clean of tiny abrasives and corrosive particles that damage superfinished surfaces. In binocular assembly for example, Precipitron prevents dust from entering the enclosure between lenses which would later settle on lens surface.

TEXTILE MILLS . . . Installed in mills as part of the air humidifying and distributing system, Precipitron removes damaging particles before they soil yarn or thread. All smoke, dirt, soot and dust is banished during drying, spinning, and winding operations. Precipitron operation is simple . . . noiseless.

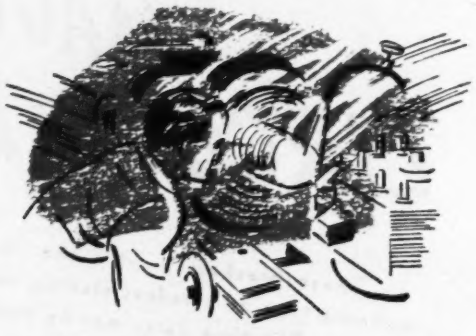


STEEL MILLS—POWER PLANTS—SUBSTATIONS . . . Precipitron effectively reduces maintenance shutdowns by eliminating the excessive dirt on machine windings which causes temperature rises and fires . . . prevents electrical breakdowns caused by leakage over the surface of dirty insulation . . . keeps machine ventilating systems dirt free.



CHEMICAL PLANTS . . . In plants where microscopic specks can cause imperfections in products and processes . . . or wherever miasma-free conditions are essential . . . Precipitron is a necessity. For example, Precipitron is being used in military photographic labs where a speck of dust might hide a Nazi factory in an aerial photo.

LABORATORIES . . . Regardless of outside air conditions, laboratories equipped with Precipitron enjoy perfectly cleaned air. The risk of errors in analysis . . . damage to sensitive equipment . . . threat to manufacturing or assembly operations due to dirt-laden air is positively eliminated.

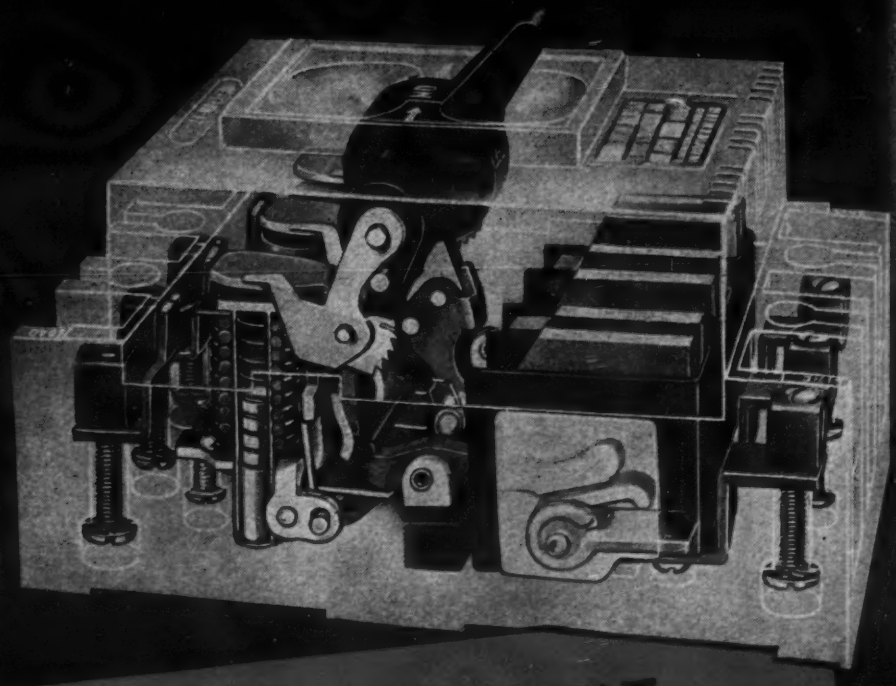


MACHINE TOOL INSTALLATIONS . . . Oil mist caused by high-speed cutting, grinding and machining is dispelled by Precipitron. Condensation of oil on lighting fixtures and bus ducts is eliminated . . . oil coolant can be recovered for re-use. Exhaust air is cleaner than surrounding shop air and can be re-circulated.

the Electronic Air Cleaner

Circuit Protection?

Put it up to



HEINEMANN MAGNETIC CIRCUIT BREAKERS

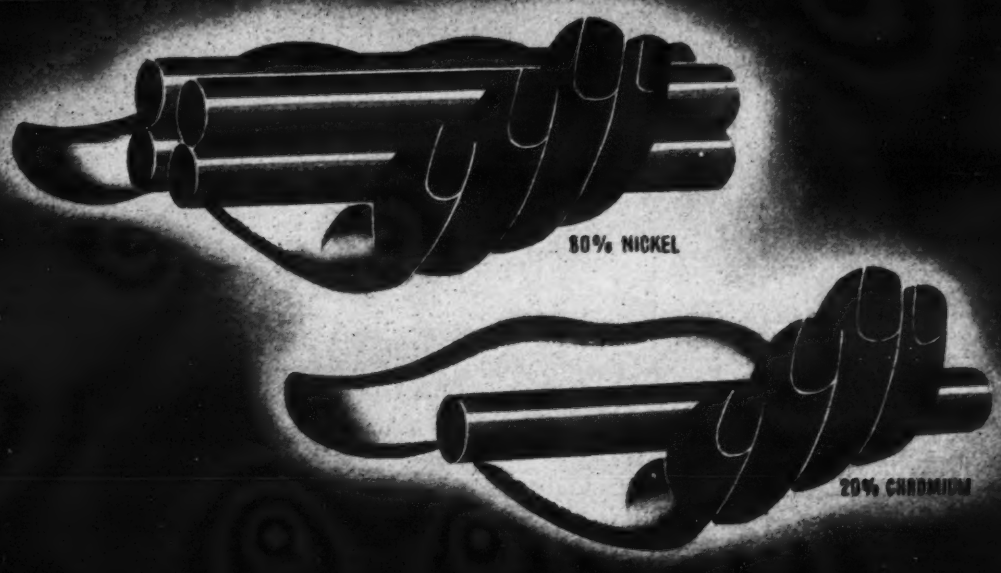
These breakers provide the ideal combination of time delay (to prevent nuisance trips on harmless starting surges) and high speed interruption of short circuits. The time delay may be matched to circuit characteristics by use of different hydraulic media. Ampere ratings between 50 milliamperes and 50 amperes may be matched accurately to the load by proper wire size and ampere turns on the magnet coil. 5,000 ampere short circuit interrupting capacity is accomplished by magnetic blowout action.

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary Heinemann Electric Co., Est. 1888

103 PLUM STREET TRENTON, N. J.

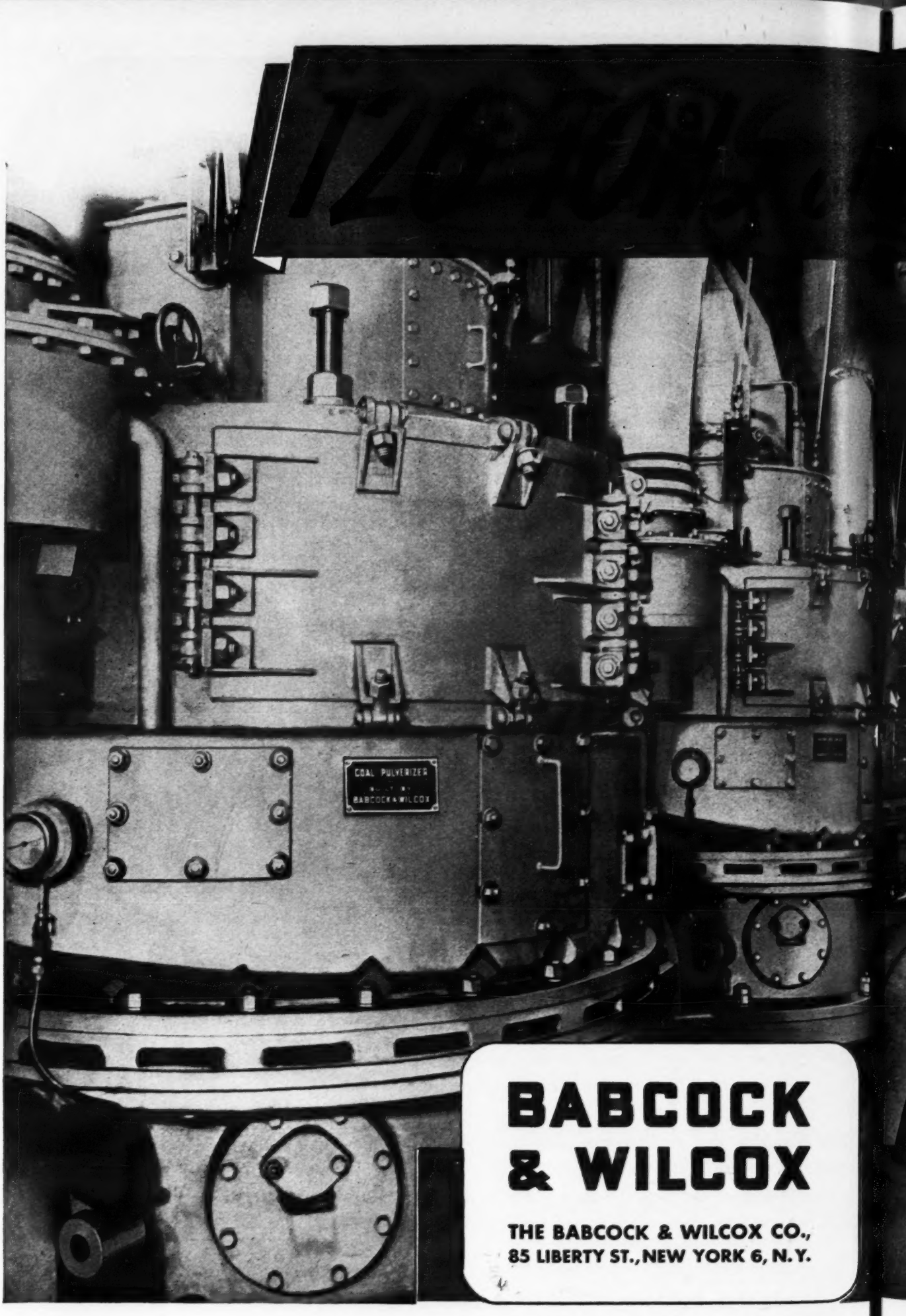
NO basic change in 38 years



When A. L. Marsh discovered the nickel-chromium resistor alloys in 1906, he found that 80% nickel and 20% chromium was the most durable composition for heating elements. This is our Chromel-A. In the 38 years since then, no substitute composition has been found. However, the Chromel-A of today has many times the durability of the original product, due to improved methods of processing the alloy, plus the tiny addition of other metals. Chromel-A is now so outstandingly durable, that one may almost say that it does not need to be improved. But it will be. For technical facts on Chromel, ask for Catalog-M.

Chromel
NICKEL CHROMIUM
HOSKINS CHROMEL
ELECTRICAL HEATING ELEMENT
WIRE

HOSKINS MANUFACTURING COMPANY, DETROIT 8, MICHIGAN



BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.,
85 LIBERTY ST., NEW YORK 6, N.Y.

ELECTRIC HOUR

Pulverizing 120 tons per hour of coal averaging 50 grindability to the fineness required for direct firing three large boilers is no great task for 12 of these 16 B&W Type E Pulverizers. Continuous operation and frequent increases in capacity caused by today's gruelling operating conditions are readily met.

Plants considering conversion to coal firing for economic and other reasons should investigate the performance of these pulverizers in connection with direct-firing pulverized-coal systems. Their reliability, ease of operation, and their ability to handle a wide variety of coals fit them into the fuel economy picture any day.

Features of the Type E Pulverizer are detailed in Bulletin G-30A. Copies will be sent on request.

Type E Pulverizer with ball-bearing grinding elements and internal fines classifier in upper section and driving elements with pressure-feed lubrication system in lower section, sealed and protected from coal dust. Primary air fan and pulverizer generally driven by same motor.

G-256T

★ BUY MORE WAR BONDS! ★

"FIGHTING WORDS"
—TAKE A LOT OF WIRE!

The ease with which wires and cables can be handled, speed with which they can be installed and readiness with which they can be maintained are tremendously important in battle-zones.

To get these advantages, the Signal Corps developed wires and cables having appreciably smaller diameters, with corresponding reductions in bulk and weight. Working in close cooperation with Signal Corps Engineers, U.S. Rubber Company engineers contributed the Laytex process.

Long before the war, this process was used for insulating small diameter wires for building, commercial and control circuits. The Laytex process made possible the famed lightweight Laytex Assault Wire of front line use, and has been adapted to a wide variety of other wires and cables for Ordnance, Corps of Engineers and the Navy.

When the day comes that we can again make peacetime versions of these smaller diameter wires and cables they will bring you extra advantages in meeting the increased capacity requirements of the vast new wiring, re-wiring and re-conversion markets. Smaller wires will save shipping and storage space—handling and installation will be easier.

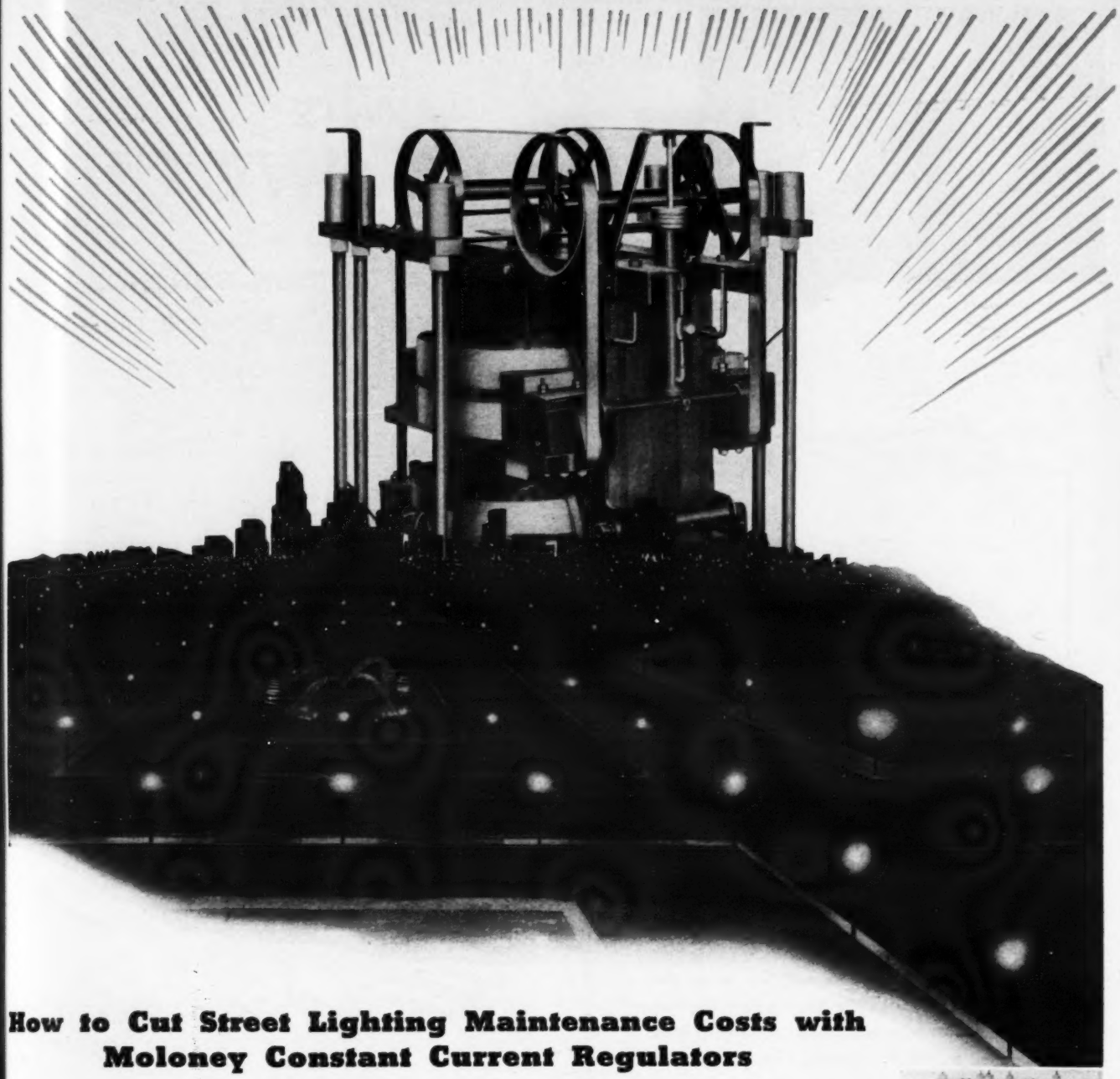
Laytex WIRES AND CABLES — **SERVING THROUGH SCIENCE**

THE SCIENTIFICALLY CONTROLLED LAYTEX PROCESS is an exclusive method of (1) specially preparing and compounding wire insulation ingredients, and (2) applying the insulation. Purification operations remove 90% of moisture and water soluble impurities from liquid latex so as to form the basis for insulation of unusually high dielectric strength. Repeated dipping and drying followed by vulcanizing results in building up a homogeneous, small diameter insulation in which conductors are perfectly centered. The process is adaptable to the use of synthetic rubbers as well as natural rubber. In either, the insulation is compounded to resist extremes of temperature, from tropical heat to sub-zero cold. Evidence of this property is the global use of Laytex wires and cables by our Armed Forces.

Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE, ROCKEFELLER CENTER, NEW YORK 20, N. Y. • In Canada: DOMINION RUBBER CO., LTD.



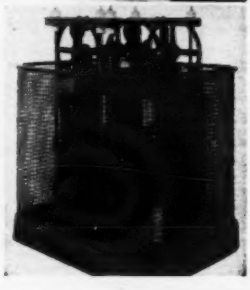
How to Cut Street Lighting Maintenance Costs with Moloney Constant Current Regulators

Poor regulation and sluggish action of regulators on series street lighting circuits result in abnormally short lamp life. Replacement of lamps is costly. Extra attention and repairs to old style single-moving coil regulators are also costly.

Moloney constant current regulators incorporate the exclusive Moloney *double-moving-coil* feature which provides *closer* regulation through all ranges of load. Unlike ordinary regulators, on these the primary and secondary coils *both* move. On changes in load or on primary surges, normal secondary current is more quickly attained since each coil moves half the distance that the single coil would move on an ordinary regulator.

Closer regulation and quicker coil action of Moloney regulators will provide longer lamp life. Sturdy construction and ball-bearing equipped moving parts make these units require a minimum of attention.

In addition to the Automatic Station Type regulator pictured, Moloney manufactures Pole and Subway types of regulators. For detailed information on all types write for Bulletin CC-3803.



Automatic Station Type Regulators are supplied with low-loss safety guards as standard equipment.

MOLONEY ELECTRIC COMPANY • ST. LOUIS, U.S.A.

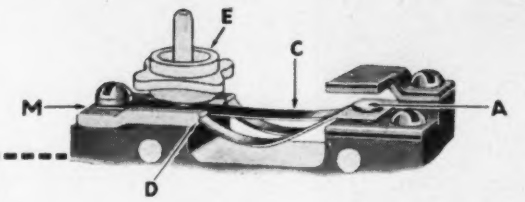
POWER AND DISTRIBUTION TRANSFORMERS EXCLUSIVELY SINCE 1896

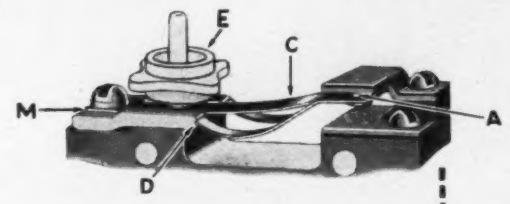
Why MICRO SWITCH

is Recognized as the LEADING SNAP-ACTION CONTROL FOR ELECTRIC CIRCUITS

Experience of electrical engineers with millions of Micro Switches has proved Micro Switch to have performance ability never before found in snap-action electric switches.

This Micro Switch performance is made possible by the use of the unique field-tested and proven operating principles. The snap-action of the Micro Switch contact is in the same direction as that of the operating plunger. There are no reverse bends in the Micro Switch spring and there is no life-limiting "oil-can" action.





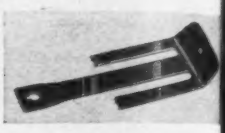
OPERATING PRINCIPLE IS RIGHT

Micro-Switch operating principle, illustrated here, is simple and fundamentally correct.

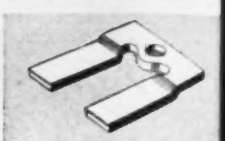
The long member of the one-piece spring "C" is supported as a cantilever at "M". The two shorter compression members of the spring rest in specially shaped (patented) V's. When the plunger "E" deforms the long tension member, the cantilever force overcomes the vertical force supplied by the compression members and the free end of the spring "A" snaps the contact from one stop to the other with lightning fast speed. Snap-action in the reverse direction occurs when the deformation of the tension members of the spring by plunger "E" is removed.

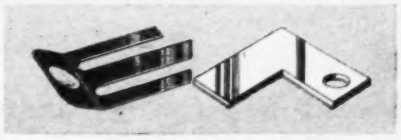
CONSTRUCTION IS RIGHT

The Micro Switch spring is made in one piece of beryllium copper. It is held to an accurately gauged thickness of .0085" and is heat treated to provide high resistance to fatigue. Every lot is under laboratory control to insure high flexure life—5,000,000 operations to full plunger overtravel for minimum.



The short compression members of the spring pivot in the patented V-grooves of the sturdy brass anchor is illustrated here. The specially finished edge of the compression members of the spring reduce friction to a minimum.





The contact end of the spring is fitted with a riveted radius type contact of 99.95% fine silver. As the plunger is actuated this contact moves from one position to the other in 3/1000 to 5/1000 of a second with a rolling action which minimizes the effects of welding. *The stationary contact* is a flat inlay of 99.95% fine silver. Its large area provides maximum heat dissipation.

The operating plunger consists of a highly polished, stainless steel pi moulded into an accurately mould star-shaped Bakelite head. T star-shaped plunger head cann rotate within the housing, insuri against any large variation point of operation. The Bakeli head comes to rest against t anchor within .020" after actua tion occurs, thus preventing exce sive overtravel, and insuring max mum spring life.

¶ **"Uses Unlimited"—a dramatic talking motion picture of Micro Switches, in color, is available to industrial groups, training classes, schools and colleges, through Y.M.C.A. rental libraries in all cities. Size: 16 mm. Length: 40 minutes. Write us for details.**

LET'S ALL
BACK THE ATTACK
BUY EXTRA WAR BONDS

★ ★ ★

Micro Switch Corporation, Freeport, Illinois
Branches: 43 E. Ohio St., Chicago (11) • 11 Park Pl., New York City (7) • 4900 Euclid Ave., Cleveland (3) • 1709 W. 8th St., Los Angeles (14)
Sales & Engineering Offices: Boston - Hartford

Send for this Catalog

Your up-to-the-minute engineers will thank you for keeping them informed about the Micro Switch. Send for as many of the Hand-Book-Catalog illustrated here as you think necessary.

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

MICRO MS SWITCH

Made Only By Micro Switch Corporation . . . Freeport, Illinois, U.S.A.

THESE BODIES ~~CAN TAKE IT~~ are taking IT

Seldom, if ever before, has it been necessary for body equipment to turn in an efficient day's work after it has been in active service 'way past the normal depreciation period.

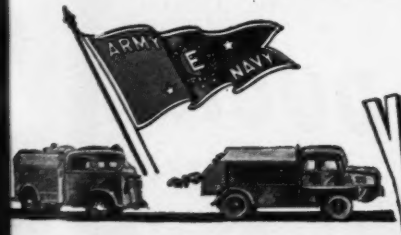
This is just one of the stringencies of war times.

It is also the supreme test of all we've ever said about the ability of York-Hoover Bodies "to take it".

Everywhere York-Hoover Bodies "ARE taking it", turning in enviable records for efficiency and toughness; proving that skillful engineering, the right materials plus long years of experience are still the best insurance for constant, trouble-free operation.

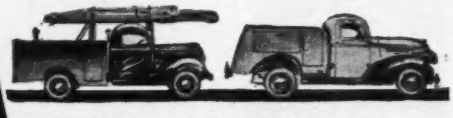
You are probably in need of new equipment, light or medium duty service units, or heavy duty line equipment.

We'll be glad to help you with your plans and when it is again possible, will produce for you body equipment incorporating all the old and proven features plus the NEW things we have learned in body production.



BODY DIVISION

YORK-HOOVER CORPORATION



YORK, PENNSYLVANIA

These Ducts
HAVE WHAT IT TAKES
—for reliable cableway service

Here are some outstanding reasons why J-M Transite Conduit and Korduct serve so well under the most severe conditions—

Inorganic . . . made of an asbestos and cement composition which provides permanence and strength, makes the ducts immune to rust or rot.

Permanently smooth bore . . . long cable pulls and replacements are made easier. Danger of damage to cables is minimized.

Easily and quickly installed . . . long, light-weight lengths and simple assembly method assure rapid, economical installation.

Immune to electrolysis . . . being entirely inorganic and non-metallic, these ducts are not affected by electrolytic or galvanic action.

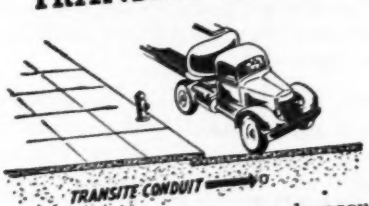
Lower cable temperatures . . . an advantage resulting from a relatively high rate of heat dissipation.

Incombustible . . . won't contribute to the formation of dangerous smoke, gases, or fumes. If burnouts do occur these inorganic ducts provide maximum protection to adjacent cables and permit easy removal of damaged conductor.

* * *

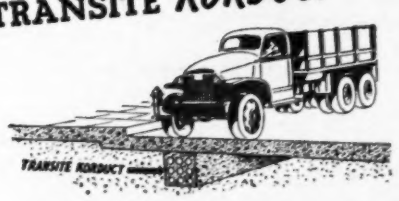
For complete details on Transite Ducts, write for Data Book, DS-410, Johns-Manville, 22 E. 40th St., New York 16, N. Y.

TRANSITE *CONDUIT*



For exposed work and use underground without a concrete encasement.

TRANSITE *KORDUCT*



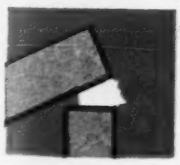
For installation in concrete. Thinner walled but otherwise identical with Transite Conduit.

JOHNS-MANVILLE **TRANSITE DUCTS**

arcs leave this point Fast!

A POINT TO REMEMBER!

LIKE THIS. Diamond-pointed break jaws confine arcing to the point . . . force the arc to break outside the current carrying area. Contact surfaces stay clean . . . don't pit, don't burn.



NOT LIKE THIS. When ordinary safety switches are opened, the arc leaps across the contact areas . . . along the jaws and blade. It hangs on longer, burns and pits the contact surfaces.

When arcs hang fire, switch contacts become pitted and burnt . . . cause trouble. To avoid this, keep the arc away from the contact area—*and* put it out *quick!*

Westinghouse Safety Switches do *both*. The diamond-pointed jaw forces the arc to break outside the current-carrying area. Contacts stay clean, last longer, need less care, provide better protection.

For 575 or 600-volt circuits, Westinghouse provides extra protection—the exclusive "De-ion" arc quencher. Arcs are drawn into the grid chamber—divided—quenched quickly!

Protect circuits with Westinghouse Safety Switches. Ratings up to 1200 amps, 600 volts. Call your Westinghouse Representative today. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Dept. 7-N.

J-21299

Westinghouse SAFETY SWITCHES

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HOW MANY MAN-HOURS PER-MILE-PER-YEAR FOR MAINTENANCE OF YOUR TRANSMISSION LINES ?

In dollars-and-cents, transmission line patrol and maintenance is an important item in normal times. In wartime, man-hours on this job are even more critical. A line on Lapp Line Posts is a year-in-and-year-out economy on either count. Power arcover, stones or bullets, even severe enough to rip a couple of petticoats off, leaves these rugged posts with ample security to do their job. Fog-type design eliminates need for cleaning. Puncture and cracking are unknown in these units. The records on hundreds of installations, in notoriously tough areas, show that it's safe to eliminate most patrol cruises, and that insulators maintenance of all kinds is only a fraction of that on conventional high-voltage insulators.

LAPP LINE POST and STATION POSTS on your system offer . .

POWER ARCOVER. *Flashover and leakage distances are not appreciably lowered by damage —even loss of several petticoats.*

NO PUNCTURE. *Puncture path in Lapp Post design is as great as flashover path. Insulator will flash over rather than puncture.*

NO CRACKING. *One piece post body, not subject to bursting from tension strains created by thermal changes in nested parts.*

RADIO INTERFERENCE. *By virtue of design factors alone, radio interference is permanently prevented at rated neutral voltage.*

NO CLEANING. *Fog-type design preserves uniform leakage path, prevents leakage flashover, makes the unit "self-cleaning."*

MECHANICAL RUGGEDNESS. *Stones or bullets deflect off, or rupture petticoats, leaving post body intact and insulator secure.*

Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, N. Y.

G & W POTHEADS

SOLVE YOUR CABLE TERMINATING PROBLEMS

WEBSTER—Pothead (pot-hed) n. Elec.—A form of terminal hermetically sealed to the sheath of an electric cable for making a moisture-proof connection between the wires within the cable and those outside.

G & W POTHEADS more than meet Webster's definition of potheads. They more than provide positive, hermetic sealing against entrance of moisture. They also prevent leakage of compound or cable-impregnating oil. Not just in fair weather and while they're new—but in all weathers and for years upon years. That is the definition of G & W POTHEAD value and service. It is also why so many representative utility companies define G & W as the potheads upon which they standardize.

Send for copy of Bulletin No. 392 which lists standardized potheads.

G & W ELECTRIC SPECIALTY CO.
7780 DANTE AVENUE - - - CHICAGO, ILL., U. S. A.
In Canada—Powerlite Devices, Ltd., Toronto

What's behind

PINCO INSULATORS

8. In the manufacture of an insulator it is vital that the mixture of clay, flint and feldspar be completely and uniformly suspended in the water with which it is mixed. To make sure that every mix measures to the high Pinco standards samples are regularly taken for viscosity tests.

More engineering goes into the manufacture of an Insulator than into most electrical products.

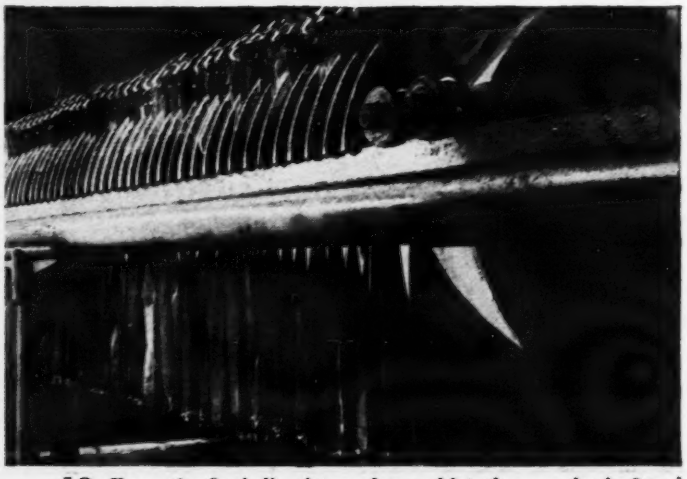
This is the second of a series of advertisements showing the many operations and tests involved in producing wet *plastic process* porcelain.

Send for your copy of the Pinco Catalog showing Pinco Standard Insulators and Hardware and including an identification of styles permitted under WPB order L-154.

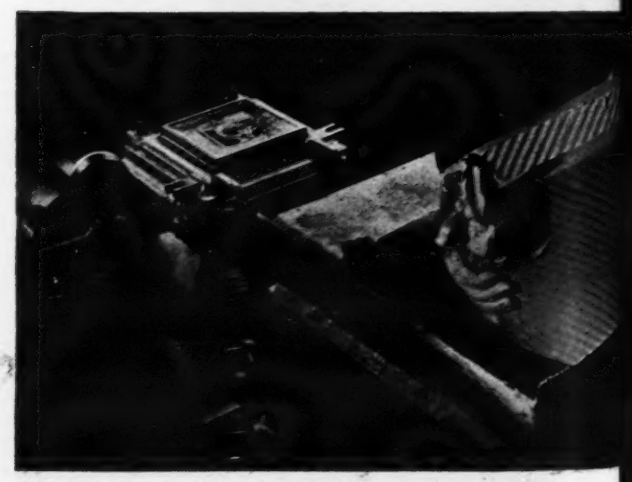
Pinco Standard Insulators are catalogued in the Electrical Buyers Reference.

9. While the viscosity meter shows the uniformity of suspension in the clay-water mix, the Baume Gauge applied to the same sample shows the *amount* of solids suspended in the water. This is read in degrees Baume.

11. When the water has been removed from the clay, the filter presses are opened and the moist clay, now of uniform density and moisture content, is removed in the form of the large, flat filter cakes shown here.



10. From the final slip cistern, from which the samples in 8 and 9 are taken, the liquid mixture is pumped into this battery of filter presses. Subjected to a controlled uniform pressure, all of the surplus water is pressed from the clay.



12. The "filter cakes" are fed into a vacuum pug mill where they pass through a shredder under a high degree of vacuum. This removes all entrapped air and insures uniform grain structure at maximum density.

Suspension Insulators . . . . Switch & Bus Insulators . . . . Distribution Pin Types and Guy Strains . . . . One Piece & Multi-part High Voltage Pin Types . . . . Suspension & Strain Clamps . . . .

"RIGHT on the job" service

14. Old fashioned "Know-How" plus the most modern vacuum pug mills produce all Pinco wet *plastic process* clay. Note the "Shaking-Down" test, a simple, time-proven method for checking the plasticity and grain structure of a section of pugged clay.

13. The plastic clay is extruded from the pug mill as a continuous rod or bar, the shape or size depending upon the insulator into which it is to be made. Sections of the exact length required are cut off, ready for the forming operations.

Pinco 1060

In making porcelain by the wet plastic process... the method used in the manufacture of all Pinco Insulators... all handling, molding and shaping operations are performed with the clay in *plastic* form, as opposed to the methods used in the dry process or cast process. The wet plastic process permits better, more uniform distribution of the clay mixture and results in maximum density in forming under heavy pressures. The result is a porcelain of far greater strength which will be "*right on the job.*"

The Porcelain Insulator Corporation

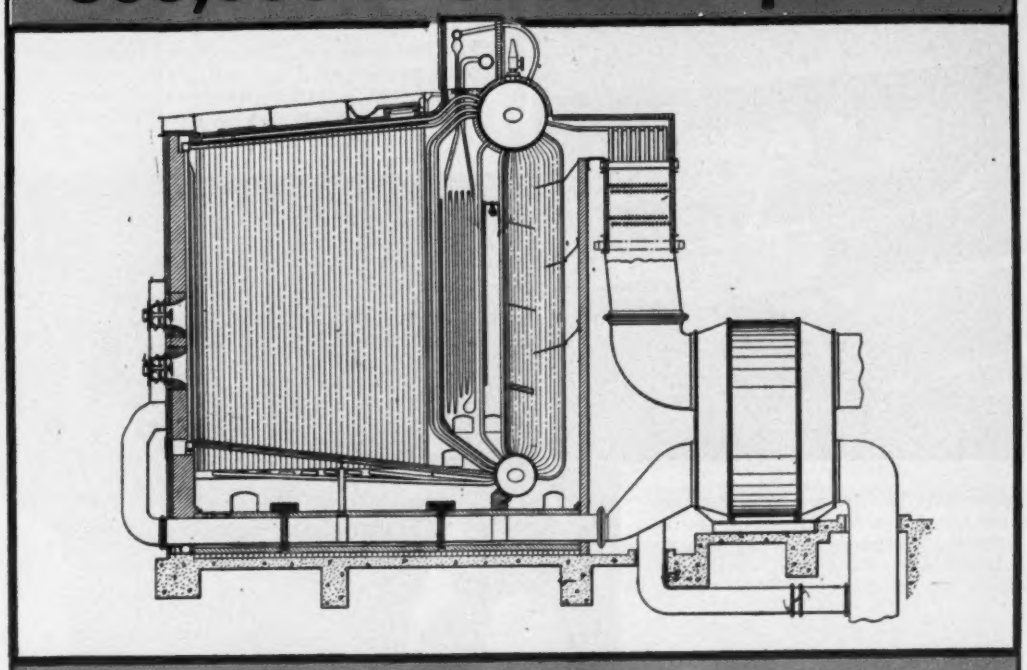
652 Main Street, Lima, New York

SALES AGENTS—JOSLYN MFG. & SUPPLY CO., Chicago 6, Ill.; Kansas City 16, Mo.; Monticello 2, Ind.; Omaha 4, Neb.; Springfield, Ill.; The Joslyn Company, New York 5, N. Y.; Baltimore 25, Md.; Philadelphia 2, Pa.; Richmond 21, Va.; Rochester 10, N. Y.; Washington 8, D. C.; South East Joslyn Co., Cincinnati 7, Ohio; Atlanta 3, Ga.; Cleveland 13, Ohio; Jacksonville, Fla.; Lexington, Ky.; Jobbers Supply Company, St. Paul 4, Minn.; Portland 9, Ore.; Seattle 4, Wash.; Southern Joslyn Co., New Orleans 19, La.; Joslyn Southwest Co., Dallas 1, Tex.; Houston 4, Tex.; Joslyn Co. of California, Los Angeles 11, Calif.; San Francisco 3, Calif.; H. E. Burns, Pittsburg, Pa.; Paul A. Douden Co., Denver 2, Colo.; Paul Carson, Amarillo, Tex.; J. J. Costello, Boston 16, Mass.

Distribution Clamps . . . . Transmission Line Fittings . . . . Transformer & Circuit Breaker Bushings . . . . Indoor Bus Support Porcelain . . . . Tree Insulators . . . . Lightning Arrester Porcelain

RANGE OF CAPACITIES, TEMPERATURES

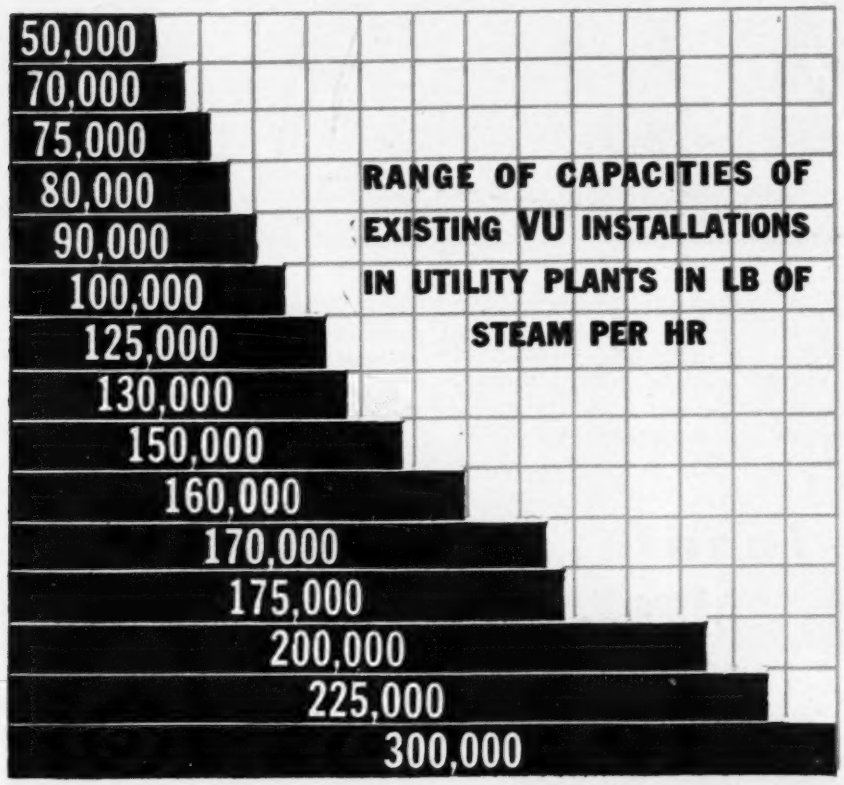
300,000 lb of steam per hr



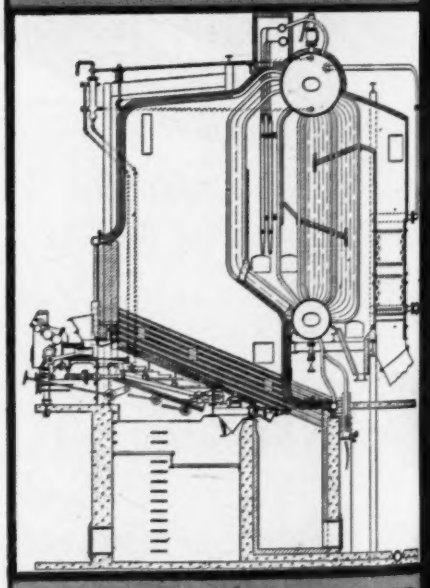
OIL FIRED

Total steam temp.—905F

Design pressure—1000 psi



70,000 lb of steam per hr



MULTIPLE RETORT STOKER

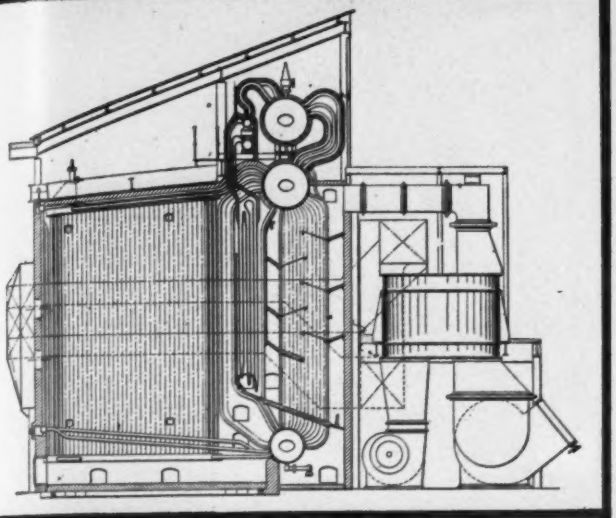
Total steam temp.—510F

Design pressure—250 P

RESSURES, AND VARIETY OF FUELS

mphasize adaptability of the VICTORY UNIT
utility requirements

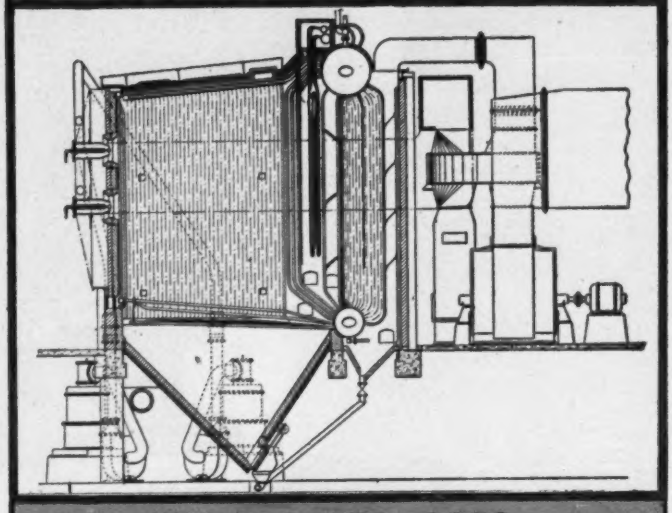
00,000 lb of steam per hr



NATURAL GAS OR OIL

steam temp.—760F Design pressure—525 psi

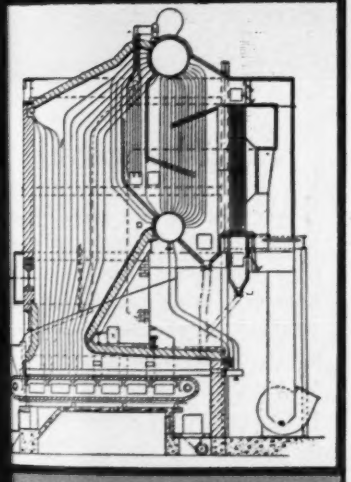
150,000 lb of steam per hr



PULVERIZED COAL

Total steam temp.—689F Design pressure—300 psi

,000 lb of steam per hr



AVELING GRATE STOKER

steam temp.—650F Design pressure—450 psi

The large number and great variety of existing utility installations, in terms of steam capacity, diversity of fuels and firing methods, and geographic distribution not only show the broad application of the Victory Unit within its capacity range but also stress the endorsement given to this standardized design by utility engineers.

The capacity range is graphically presented on the left page with installations of 15 different sizes in the range from 50,000 to 300,000 lb of steam per hr showing how precisely the Victory Unit can be brought to meet your particular requirements. Design pressures are from 250 to 1,000 psi and total steam temperatures range up to 905 F.

The variety of fuels which can be utilized is suggested by the five typical installations illustrated. They include oil firing, oil or gas, pulverized coal, and two of the four types of stokers to which the Victory Unit has been adapted.

In the matter of geographic distribution the Victory Unit has extended itself into every corner of the country, with utility installations in as many as nineteen of the forty-eight states.

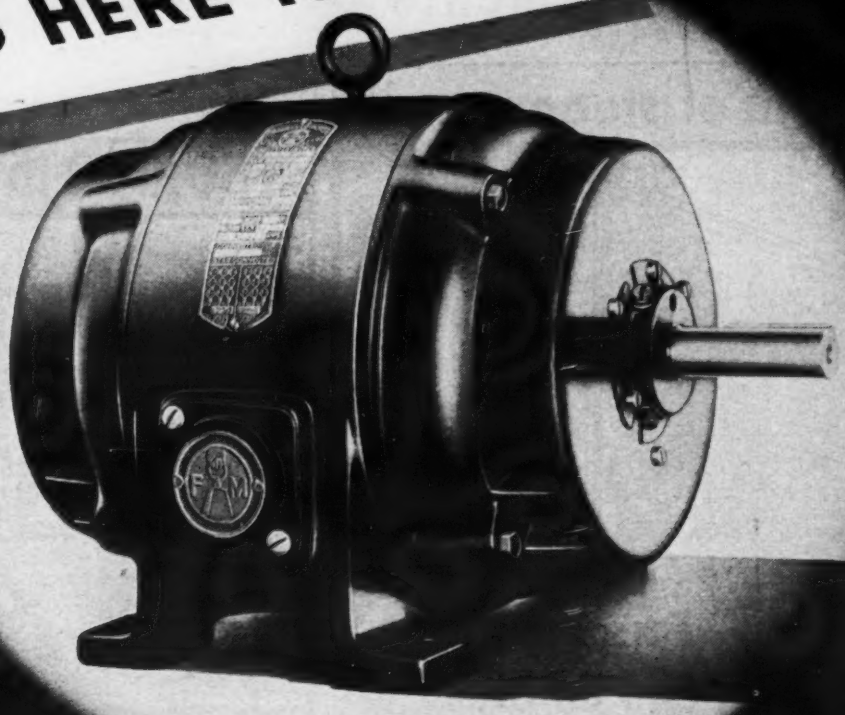
The dependable performance of Victory Units, which is re-emphasized today under the stress of wartime operation, accounts in large measure for this widespread acceptance by utility engineers.

A-790

COMBUSTION ENGINEERING

00 MADISON AVENUE NEW YORK 16, N. Y.

TOMORROW'S MOTOR IS HERE TODAY!



WITH *Copperspun* ROTOR

YOU can buy this new postwar designed Fairbanks-Morse motor now—*knowing* that it will be just as modern—just as efficient—just as up to the minute in years to come as it is today.

It is indeed a challenge to the future—in efficient motor design.

- It is a 40°C. motor.
- It is a protected motor!
- It has the most adaptable, convenient, and handiest conduit box you ever laid your eyes on!
- It has the famous Fairbanks-Morse COPPER-SPUN Rotor!

Important!

Never before has there been more stamina—more protection—more versatility built into a motor housing. A demonstration is necessary to fully appreciate how much this motor can really offer you. See it and judge for yourself.

Write Fairbanks, Morse & Co., 20 Fairbanks-Morse Bldg., Chicago 5, Ill.

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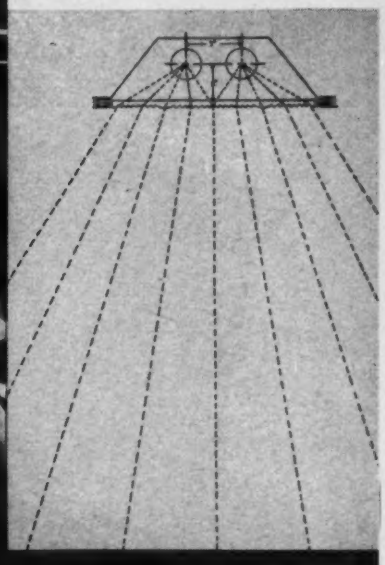
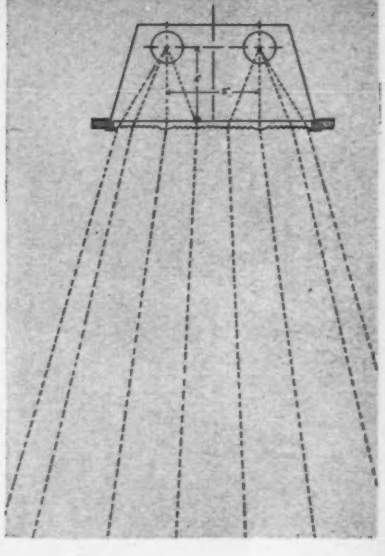
DIESEL ENGINES
PUMPS
MOTORS
GENERATORS
WATER SYSTEMS
SCALES
STOKERS
FARM EQUIPMENT
RAILROAD EQUIPMENT

Motors

Engineering Dept., Boeing Airplane Company, Wichita, Kans. Two tube recessed fluorescent troffer lighting units with diffusing lenses installed in continuous bands six feet apart provide glare-free illumination of 50 foot-candle intensity. Installation by Austin Co.





CORNING ENGINEERED *Flur-o-guides**

BETTER LIGHTING THROUGH GUIDED LIGHT...

SATISFIED CUSTOMERS... *more profit for you*

It's easy to sell efficient, adequate lighting, and profitable too. Recommend the correct engineered fluorescent lighting installation . . . one that is designed optically to guide the light where it is needed . . . to produce a concentrated or wide angle beam of light. Show your customer how an engineered installation gives adequate light without interference of glare in the normal line of vision. You can prove to him that engineered lighting is the *only* way to insure maximum see-ability with minimum brightness.

WHAT IS ENGINEERED LIGHTING?

These diagrams illustrate the functions of engineered lighting†, using Corning *Flur-o-guide** lenses and panels. In this case, placement of the fluorescent tubes in relation to the focal length of the *Flur-o-guide** lens produces wide angle light distribution (upper diagram) or concentrated light beam (lower diagram). In either case, through the use of *Flur-o-guides*,* adequate light is directed where it's needed, without eye fatigue.

This is just one example of the complete line of Corning *Flur-o-guide** lenses and panels which will help you sell engineered lighting.

Write us for information on how to sell engineered lighting and thus increase your profits. Ask for your copy of "Corning Lighting Data". It's interesting and helpful. Address Lighting Sales, Consumer Products Division EW1, Corning Glass Works, Corning, N. Y.

**Flur-o-guides* . . . Lenses and Panels that are engineered to guide fluorescent light to the areas where it's needed, without eye fatigue.

†Corning Glass Works does not manufacture or sell lighting fixtures. The diagrams presented are standard types obtainable from fixture manufacturers.

"CORNING" is a registered trade-mark and indicates manufacture by Corning Glass Works.

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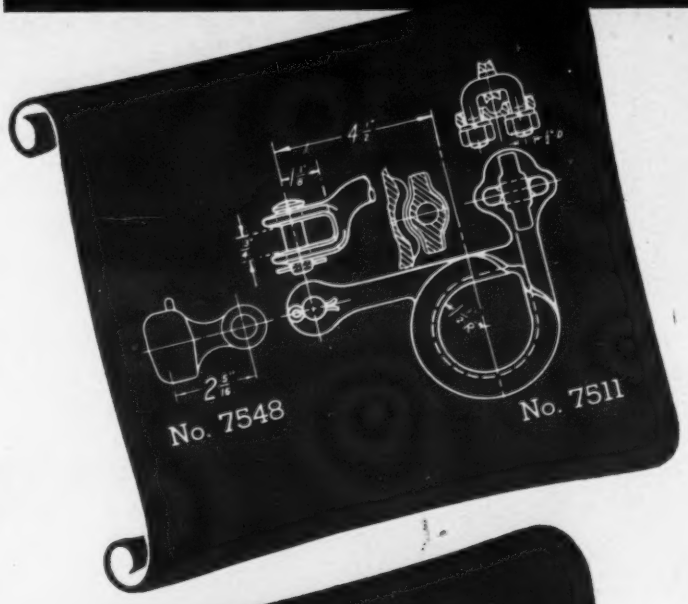
means
arch in Glass

Corning Engineered Lightingware

BRAND

Rural & Light Tran



These are the familiar and accepted snubbing type, designed for dead-ending the lighter duty transmission and distribution lines. Low in price, they are especially adapted to rural electrification and light transmission work.

The use of forged steel parts results in a light-weight clamp with more than adequate strength. This feature, together with the short connection length, protect the conductor from the possible effect of vibration.

The ample radius of snub, smooth cable seat and long clamping keeper prevent damage to the conductor and the side opening type is easy to install and work with hot-line tools. Reversible two-groove keepers accommodate a wide range of conductor sizes.

No. 7511 (without fitting). No. 7548 (with socket eye).
For all conductors within its size range.
Min. 0.16—Max. 0.55.

Not recommended for A. C. S. R. conductors larger than No. 2-0 due to their stiffness.

Ultimate strength 10,000 lbs. Shpg. wgt. 280 lbs. per C.

No. 2104 (without fitting). No. 21048 (with socket eye).
For all conductors within its size range.
Min. 0.187—Max. 0.50.

Ultimate strength 9,000 lbs. Shpg. wgt. 200 lbs. per C.

No. 2102 (without fitting). No. 21028 (with socket).
For all conductors except A. C. S. R. within its size range.
Min. 0.128—Max. 0.375.

Ideal for the popular A series Copperweld-copper or other similar three-strand composite conductors.

Ultimate strength 7000 lbs. Shpg. wgt. 145 lbs. per C.

BTC HI-LIN

THE BREWER-TITCHENER CORPORATION

nission Line Clamps

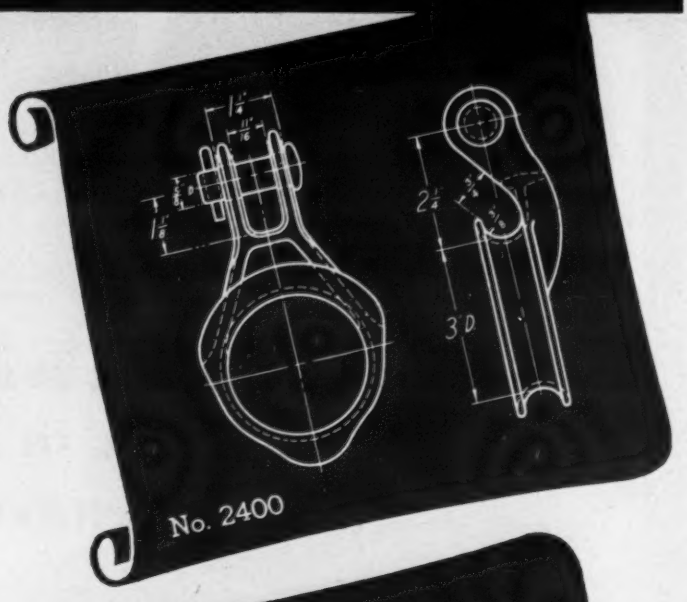
SIDE OPENING CLEVIS THIMBLE

For Angle and Strain Position
No. 2400

Suitable for all conductors generally used on Rural and Light duty transmission and distribution lines.

Note provision for the tie winds at each side of the lower part of the thimble. May also be used as a dead end thimble. Very light in weight with more than adequate strength. Side opening allows easy installation.

Ultimate strength 9,000 lbs. Shpg. wgt. 120 lbs. per C.



No. 2400

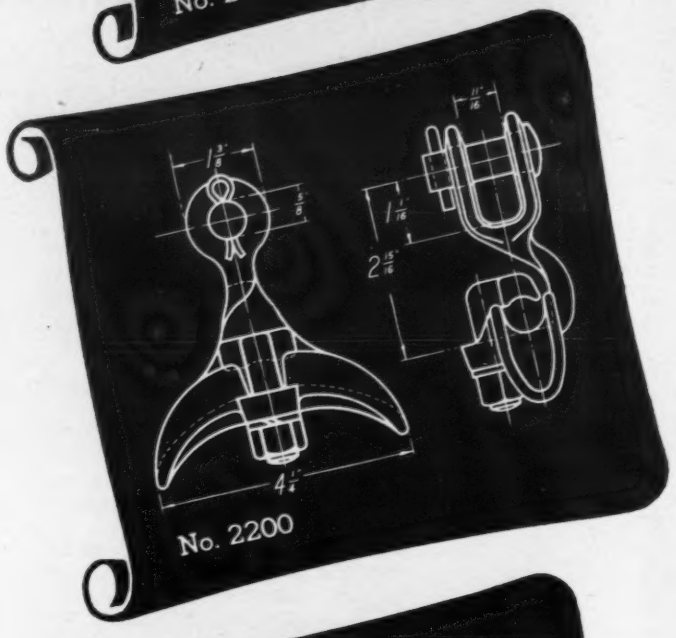
ANGLE CLAMPS

Nos. 2200 and 2300

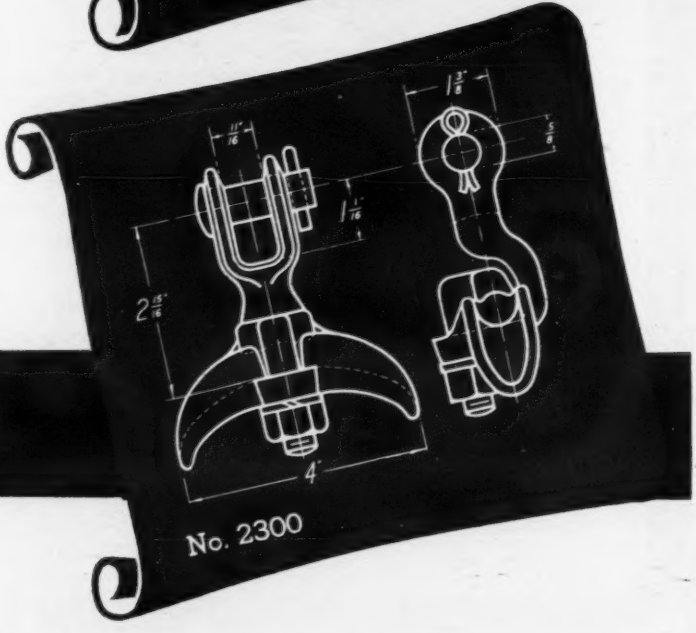
Especially designed for construction having angles of 30 degrees to 120 degrees. Suitable for all commercial sizes of conductors from .12 to .60 diameter, including armor rod or ribbon.

The three inch seat contour radius meets the requirements for A. C. S. R.—Copper, Copperweld, Copper Composite and other conductors. Side opening—easy to install or work with hot-line tools. Unnecessary to remove the T-Bolt keeper during installation.

Shpg. wgt. 145 lbs. per C. Ultimate strength 5,000 lbs.


No. 2200

AWARDED TO CORTLAND FORGING DIVISION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N HARDWARE

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Here's a convincing Guarantee of Westinghouse Insulator Performance

81.25%

OF ALL MAJOR DESIGN DEVELOPMENTS IN ELECTRICAL PORCELAIN HAVE BEEN MADE BY

Westinghouse

FARADOID PRINCIPLE improved performance of high-voltage transmission lines. Surfaces were proportioned to conform to the equipotential surfaces of the electrostatic field. Now an industry-wide standard.

HIGH-STRENGTH SUSPENSION developed to meet demands of railroad electrification. Increased load limits of suspension insulators to 25,000 and 36,000 pounds. Made possible improvements in power transmission.

RADIO-INTERFERENCE-PROOF (R.I.P.) INSULATORS, first introduced in 1930. Solved the radio reception problem caused by the usual arcing flow of capacity currents between conductor and insulator surfaces. Now an industry standard.

SOLDER SEALING is to this day the only effective means of producing a hermetic joint between metal and porcelain. Gives permanent protection to oil or air-insulated equipment against moisture or dirt.

BULLET-PROOF INSULATORS increased section thickness, and proportioned surfaces so as always to produce ricochet. Helped solve breakage due to stone throwing and target shooting.

PRESTITE—a revolutionary new porcelain, dense, nonporous with high dielectric and mechanical strength. Can be molded to intricate shapes with close tolerances.

LINE AND STATION POST INSULATORS—a co-development of Westinghouse and other engineers.

If the 8 major porcelain developments made in the past quarter century are given an equal rating, Westinghouse must be credited with 81.25% of these important improvements!

That's the record. Westinghouse quotes it, not in self-praise, but as a guide to men responsible for porcelain performance.

The research and co-ordinated engineering which made possible these advances are today at work on new projects. You are invited to co-ordinate these research facilities with your own porcelain problems and planning.

To serve your immediate porcelain insulator needs, Westinghouse maintains over 120 stocking points which assure quick delivery anywhere in the United States. Your inquiries on either present or postwar needs will be welcomed. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

J-05153

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Really modern, progressive electric light and power companies can take emergencies like this in stride.

With RCA 2-way radio on every one of their trucks, and in their shops and offices, quick action is simple.

Every one of their trucks, no matter how scattered, can be contacted instantly, and simultaneously, at any time.

The present trend toward the use of 2-way radio by public utilities is a great step forward in public welfare. RCA factories at this time are

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AM or FM
RCA Makes Both

100% engaged in war work. But RCA emergency communications equipment engineers are available to help you plan an efficient RCA system of this type for installation in your service just as soon as the war permits. Please address inquiries to Emergency Communications Section, Radio Corporation of America, Camden, New Jersey.

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★ NUMBER 7 IN A SERIES, TRACING FIFTEEN YEARS OF KELLETT ROTARY WING PROGRESS ★

A Kellett in operation-tests with a State Guard Unit, during pre-war maneuvers.

Pioneer . . . Blazing Air Trails

PIONEERING is an American tradition. Every step in America's advance has been made because pioneer spirits first endured hardships to mark new paths—trails that encouraged others to take up the journey.

The scene pictured above is just one of the blaze-marks in the fifteen year trail marked by rotary wing pioneers. The aircraft flying close to tree tops was an early model, direct-control Kellett, demonstrating its ability to hover in a slight breeze, and to take off or land on any open spot of pasture.

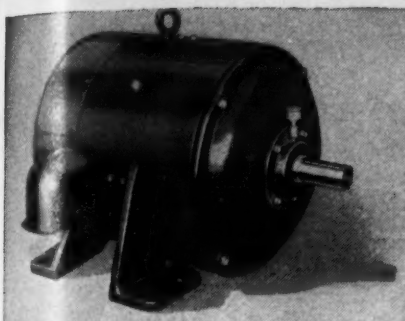
Most of this Kellett pioneering was during the most severe depression the U. S. and the world had ever experienced. It required faith to carry on with confidence in the goal ahead.

Today, Kellett's expanding staff of engineers, backed by this fifteen years of charting new paths, looks forward to Peace—when developments in rotary wing aircraft will have opportunities to serve in the patrolling and servicing of cross-country electric lines and oil pipe lines, in spraying and dusting agricultural crops, in ranching, forestry fire patrol—and many more ways. Kellett Aircraft Corporation, Upper Darby (Philadelphia), Pennsylvania.

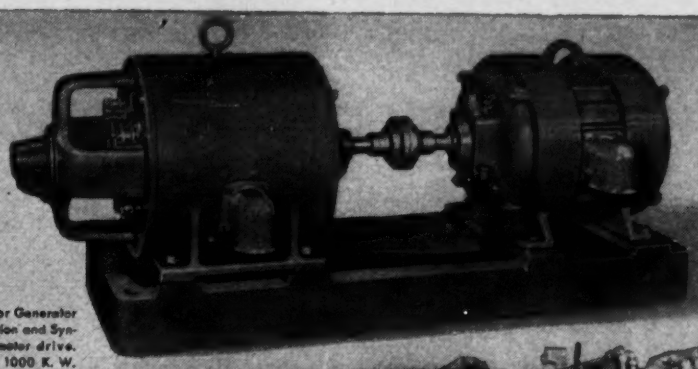
Eight years ago—a U.S.A.A.F. Kellett taking off from in front of the Operations Hangar, Wright Field, Dayton, O.

KELLETT

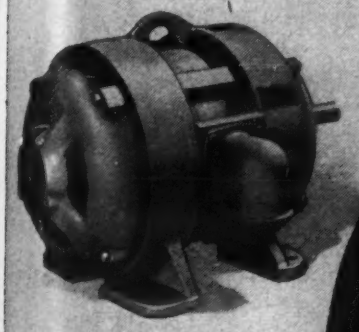
OLDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY



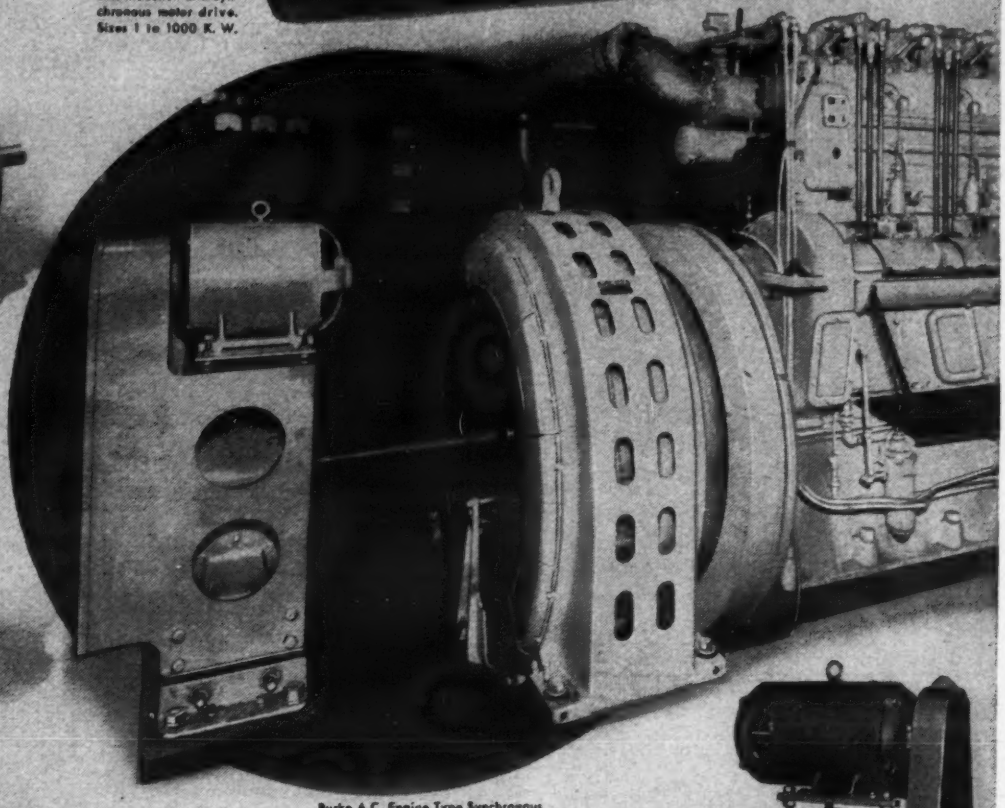
Burke Bracket Type D.C. Motors and Generators. Sizes 1 to 1000 K.W.



Burke Motor Generator Sets Induction and Synchronous motor drive. Sizes 1 to 1000 K. W.

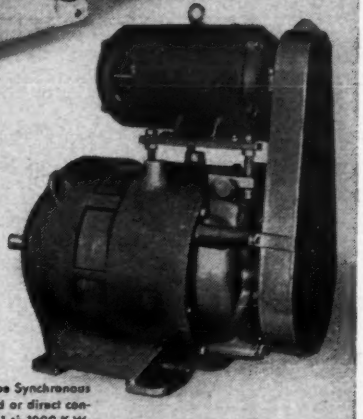


Burke Induction Motors, ball or sleeve bearing. Sizes 1 to 1500 H. P.

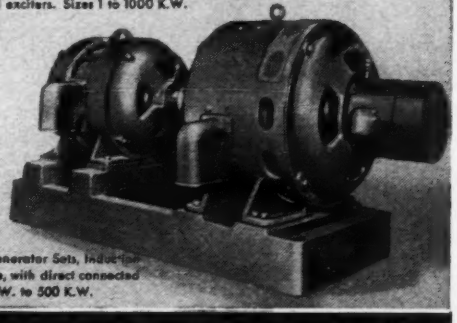


Burke A.C. Engine Type Synchronous Generators. Sizes 25 to 1000 K. W.

Burke Vertical Induction Motors for pump drive. Sizes 1 to 1500 H. P.



Burke A.C. Bracket Type Synchronous Generators with belted or direct connected exciters. Sizes 1 to 1000 K.W.



Burke High Cycle Motor Generator Sets, Induction or Synchronous motor drive, with direct connected exciters. Sizes 5 K.W. to 500 K.W.

Designed for the Job

BURKE offers to industry a highly specialized experience in applying its wide range of standardized motors and generators to meet specific requirements from one horsepower up. Wherever the maximum in capacity and overload are demanded, it will pay you to get Burke's recommendation, for Burke stresses quality and workmanship in every detail. You can depend on a Burke for more than its rating.

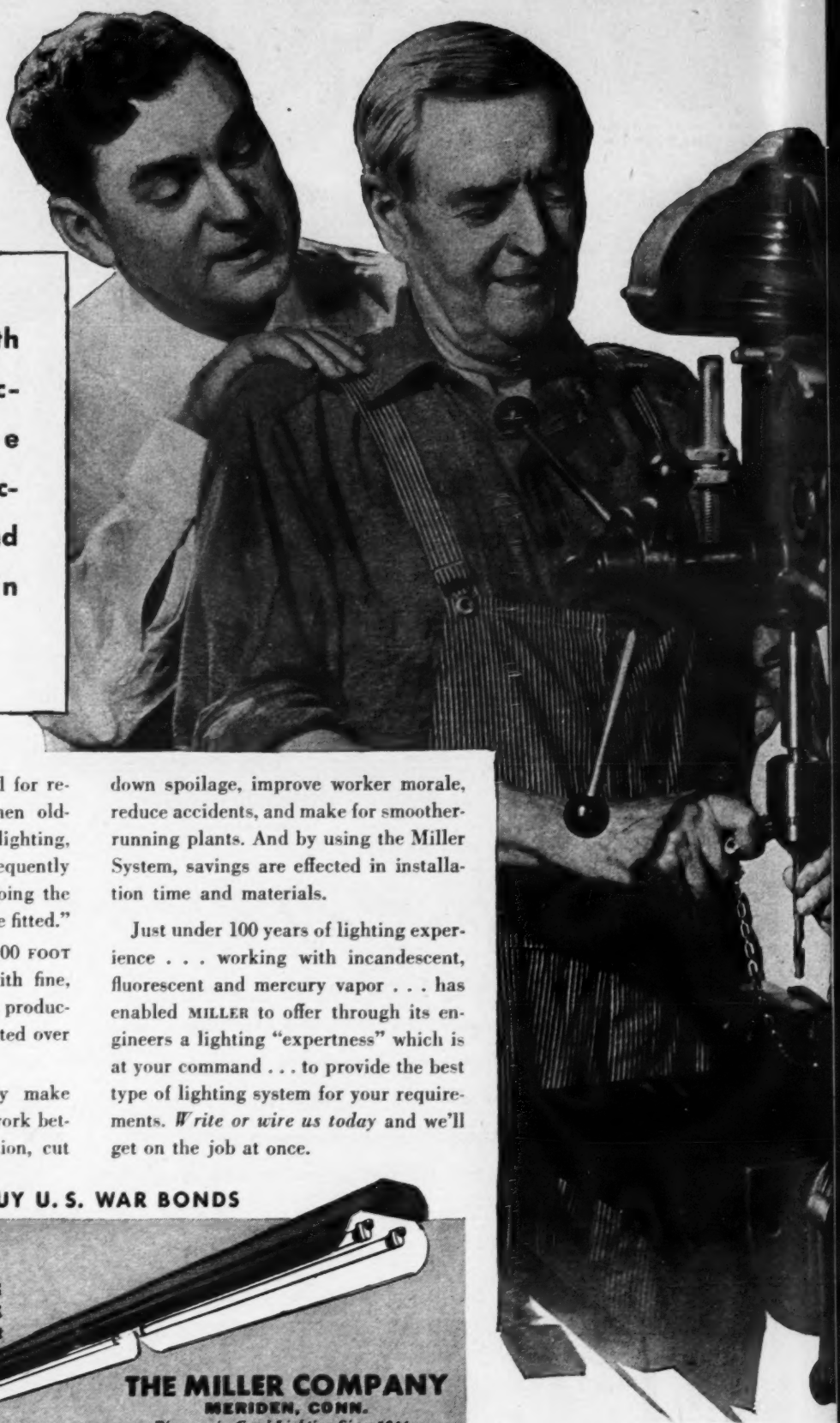
MOTORS 1 TO 1500 H. P. • GENERATORS 1 TO 1000 K. W.

BURKE A.C. & D.C. Motors & Generators

BURKE ELECTRIC COMPANY, ERIE, PENNSYLVANIA • *Since 1891*

"Gramp" YAEGER'S BACK ON THE JOB!

...and



Miller is back with 100% steel reflectors—the same rigid steel construction you knew and used and liked in 1941 and 1942.

WPB has lifted the ban on steel for reflectors! And WPB says, "When old-timers are provided with good lighting, tailored to their needs, it is frequently possible for them to keep on doing the precision work for which they are fitted."

MILLER 50 FOOT CANDLER or 100 FOOT CANDLER will provide plants with fine, man-made *daylight* . . . adequate, productive illumination evenly distributed over every working surface.

Better lighting will actually make workers see better, feel better, work better. It will help speed production, cut down spoilage, improve worker morale, reduce accidents, and make for smoother-running plants. And by using the Miller System, savings are effected in installation time and materials.

Just under 100 years of lighting experience . . . working with incandescent, fluorescent and mercury vapor . . . has enabled MILLER to offer through its engineers a lighting "expertness" which is at your command . . . to provide the best type of lighting system for your requirements. *Write or wire us today* and we'll get on the job at once.

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100 FOOT CANDLER
Continuous Wireway Fluorescent Lighting Systems

THE MILLER COMPANY
MERIDEN, CONN.
Pioneers in Good Lighting Since 1844
● MILLER offers a complete line of filament and fluorescent lighting equipment

A MILLER Message in line with WPB's helpful handbook, "Plant Efficiency."

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200 pages of...

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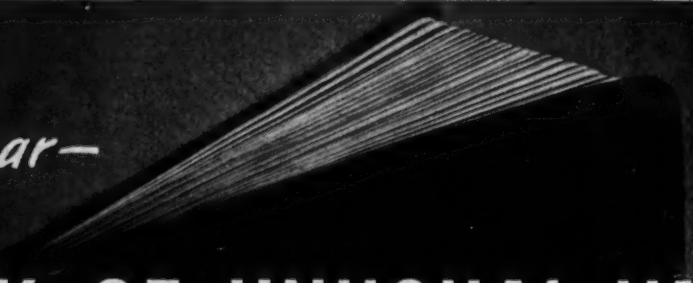
for
RADIO ENGINEERS



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Fills a real need—In presenting *"Reference Data for Radio Engineers"*, Federal Telephone and Radio Corporation has drawn on its broad experience as well as its current war activity. The needs of both the engineer and the technician have been considered. Hence much fundamental data are included to bridge the gap between the concise handbook and the standard radio engineering text book.

Timely and essential data—such as those on Fourier Analyses of Non-Sinusoidal Waves, Relaxation Oscillators, Antenna Arrays, Transmission Lines, Wave Guides and Resonators have been included. Also much pertinent information *outside* the field of radio.

For quick, easy reference—a glance at the partial table of contents shows the wide range of useful theoretical and practical data included — charts, graphs and tables, plus numerous illustrations — all arranged for ready use.

Edited for today and tomorrow — The impetus of War production has shown the need for an absolute minimum time lag between research, production and utilization of equipment. This one compact volume places at your fingertips information that should be on the desk of every radio man or woman engaged in research, development, production or operation.

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Material for this Reference was compiled under the direction of the Federal Telephone and Radio Laboratories in collaboration with other associate companies of the International Telephone and Telegraph Corporation. This group of companies possesses experience gained throughout the world over a period of many years in the materialization of important radio projects.

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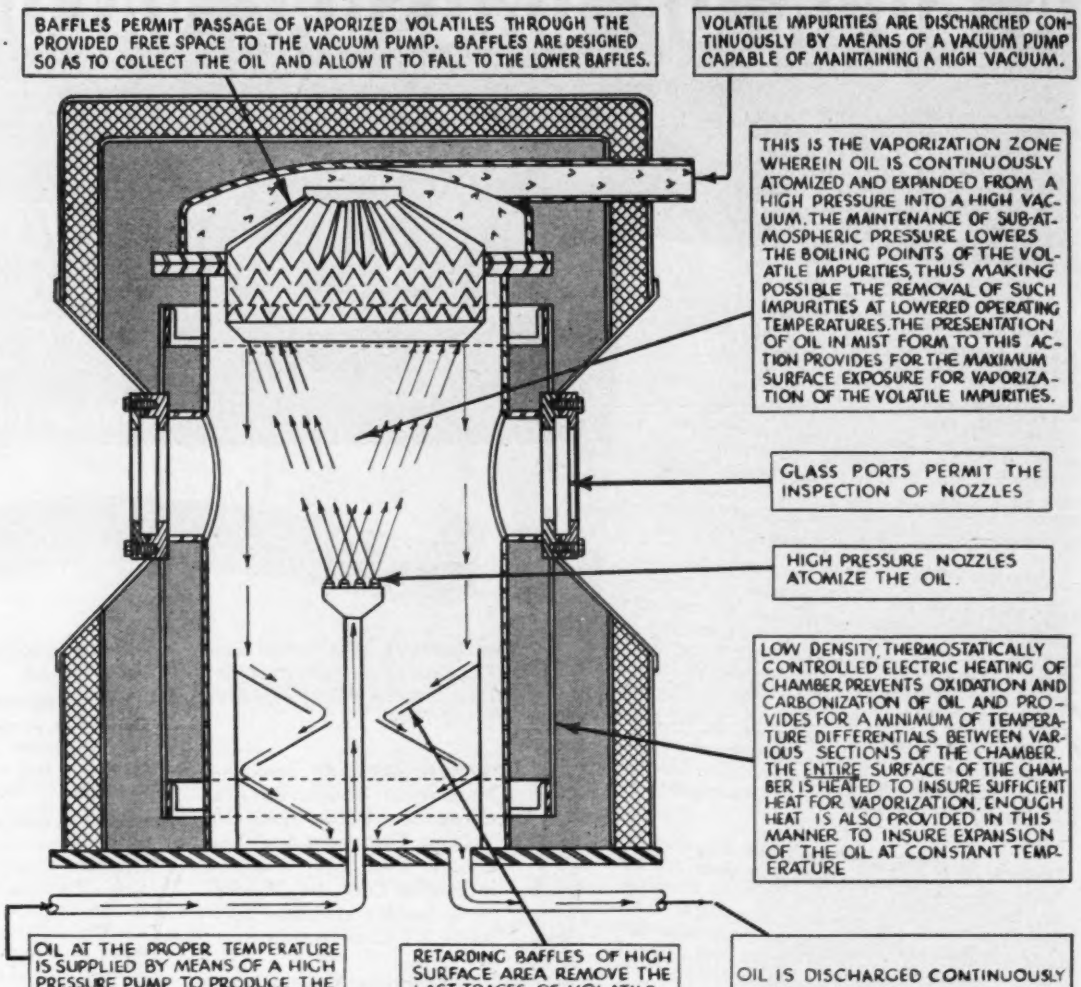
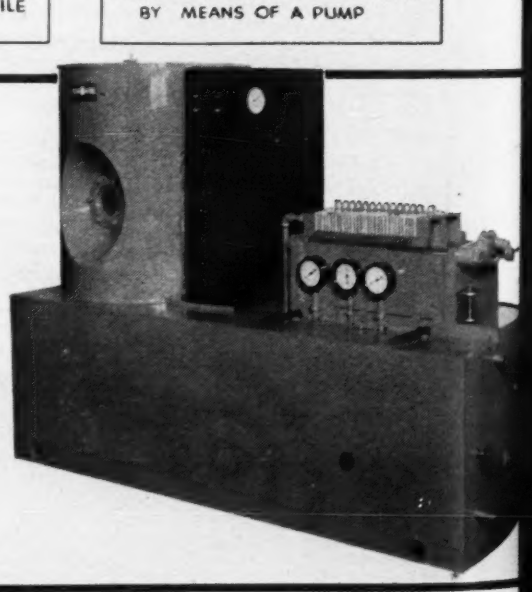
THE BUCKEYE PROCESS


BAFFLES PERMIT PASSAGE OF VAPORIZED VOLATILES THROUGH THE PROVIDED FREE SPACE TO THE VACUUM PUMP. BAFFLES ARE DESIGNED SO AS TO COLLECT THE OIL AND ALLOW IT TO FALL TO THE LOWER BAFFLES.
VOLATILE IMPURITIES ARE DISCHARCHED CONTINUOUSLY BY MEANS OF A VACUUM PUMP CAPABLE OF MAINTAINING A HIGH VACUUM.
THIS IS THE VAPORIZATION ZONE WHEREIN OIL IS CONTINUOUSLY ATOMIZED AND EXPANDED FROM A HIGH PRESSURE INTO A HIGH VACUUM. THE MAINTENANCE OF SUB-ATMOSPHERIC PRESSURE LOWERS THE BOILING POINTS OF THE VOLATILE IMPURITIES, THUS MAKING POSSIBLE THE REMOVAL OF SUCH IMPURITIES AT LOWERED OPERATING TEMPERATURES. THE PRESENTATION OF OIL IN MIST FORM TO THIS ACTION PROVIDES FOR THE MAXIMUM SURFACE EXPOSURE FOR VAPORIZATION OF THE VOLATILE IMPURITIES.
GLASS PORTS PERMIT THE INSPECTION OF NOZZLES
HIGH PRESSURE NOZZLES ATOMIZE THE OIL.
LOW DENSITY, THERMOSTATICALLY CONTROLLED ELECTRIC HEATING OF CHAMBER PREVENTS OXIDATION AND CARBONIZATION OF OIL AND PROVIDES FOR A MINIMUM OF TEMPERATURE DIFFERENTIALS BETWEEN VARIOUS SECTIONS OF THE CHAMBER. THE ENTIRE SURFACE OF THE CHAMBER IS HEATED TO INSURE SUFFICIENT HEAT FOR VAPORIZATION. ENOUGH HEAT IS ALSO PROVIDED IN THIS MANNER TO INSURE EXPANSION OF THE OIL AT CONSTANT TEMPERATURE
OIL AT THE PROPER TEMPERATURE IS SUPPLIED BY MEANS OF A HIGH PRESSURE PUMP TO PRODUCE THE NECESSARY PRESSURE FOR ATOMIZATION.
RETARDING BAFFLES OF HIGH SURFACE AREA REMOVE THE LAST TRACES OF VOLATILE IMPURITIES.
OIL IS DISCHARGED CONTINUOUSLY BY MEANS OF A PUMP

THE HYDROVOLIFIER

Can Help!—

1. Increase transformer capacity by restoring and maintaining insulating properties of oil.
2. Reduce operating temperature of transformers.
3. Increase the life of circuit-breakers, transformers.
4. Prolong the service life of oils.



CLEANS • • • DEHYDRATES • • • DEGASIFIES • • • STABILIZES

Electrical Insulating Oils, subjected to today's severe operating conditions—long service use and equipment overloads need more thorough treatment than can be given by methods commonly employed.

THE HYDROVOLIFIER

The Hydrovolifier is a physical (non-chemical) apparatus, designed to clean, dehydrate, degasify and stabilize electrical insulating oils.

It permits the servicing of equipment, such as transformers, in place without interruption of service. It is also useful for treating insulating oil removed from service at given points in the system.

PREVENTATIVE MAINTENANCE WITH THE BUCKEYE PROCESS

In the Buckeye Process (see diagram) heated oil is forced through atomizing nozzles into a vacuum chamber. This high-low pressure shock treatment removes all moisture—both free and in solution—along with all other volatile impurities from the oil.

Volatile corrosive agents, all moisture and air are removed. Treated oil not only regains its original insulating properties but also shows greater stability—stronger resistance to sludging and to emulsion. Progressive acidity is stopped.

The Hydrovolifier — employing the Buckeye Process — initially removes heavy solids through a disc-type filter, and in the final operation a blotter filter press takes out any remaining suspended solids from the dry oil.

SIMPLE, LOW-COST OPERATION

For servicing transformers in the field only three connections are made—the inlet and outlet lines and the power circuit. Pressures and temperatures are automatically controlled. No cleaning is necessary except an occasional change of filter papers and occasional draining of the pre-filter sump. One man can handle the operation.

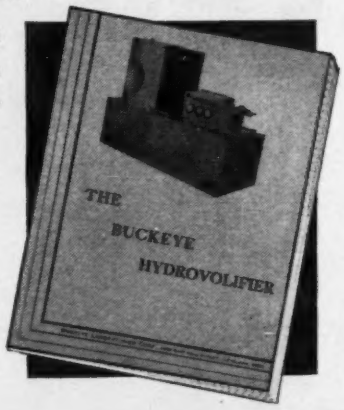
On larger models the operating costs have run slightly under one cent per gallon.

THREE STANDARD SIZES

HV-100—Capacity—100 gallons per hour with continuous blotter press filter.

HV-300—Capacity—300 gallons per hour with continuous blotter press filter.

HV-500—Capacity—500 gallons per hour with continuous blotter-type filter.



WRITE FOR HYDROVOLIFIER BULLETIN

Contains information on factors affecting performance of insulating oils—how the Hydrovolifier works; design and construction of the apparatus. Write for your copy today.

BUCKEYE LABORATORIES CORP.

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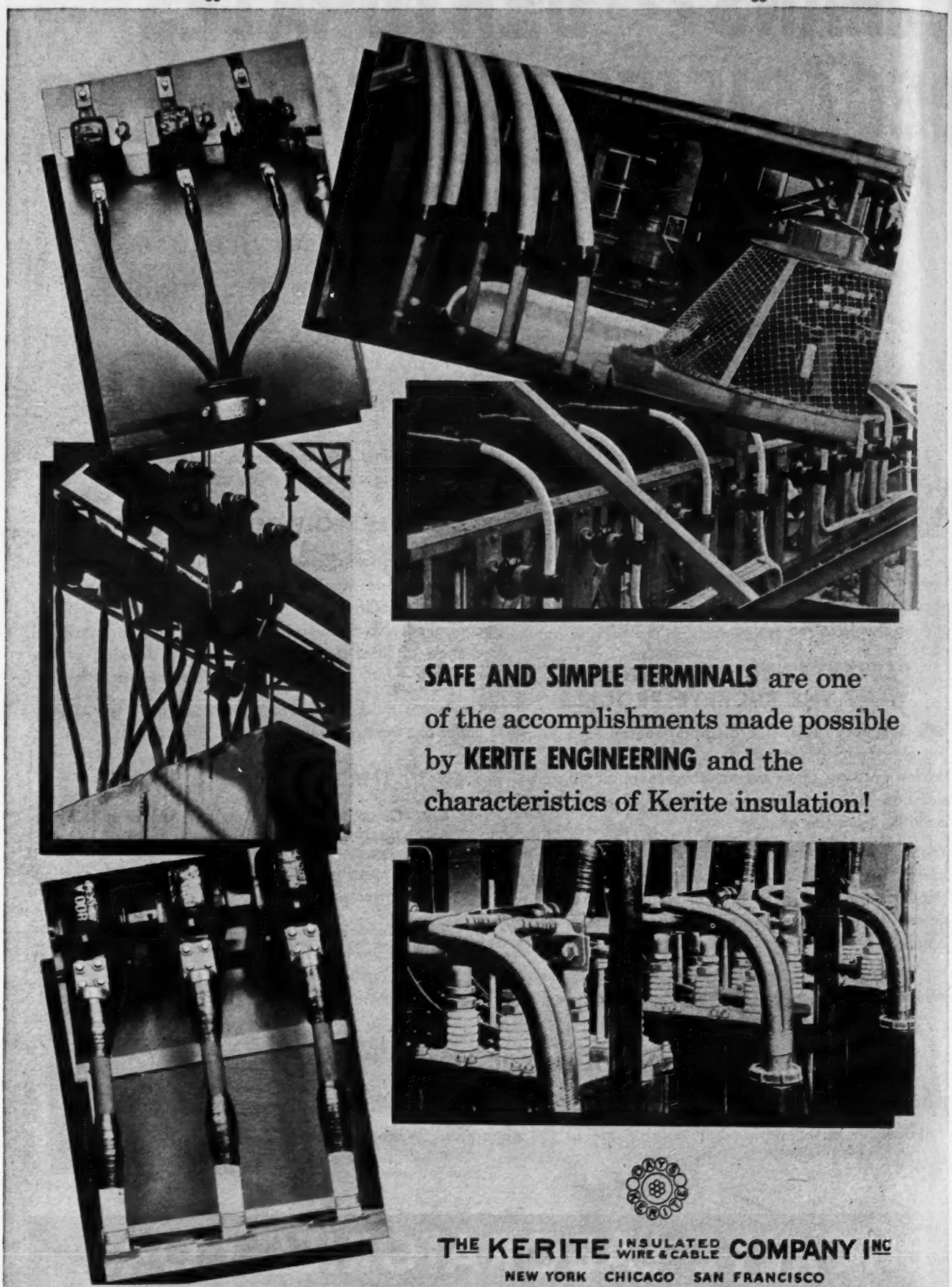
Pioneers in Cable Engineering



SAFE AND SIMPLE TERMINALS are one of the accomplishments made possible by **KERITE ENGINEERING** and the characteristics of Kerite insulation!

THE KERITE INSULATED WIRE & CABLE COMPANY INC
NEW YORK CHICAGO SAN FRANCISCO

Minimum and Maximum Essentials

What is the minimum electric service essential to the life of a community that has experienced full service? It is to be hoped that we in this country may never have to find the answer to that question, but it is certain that Europe will, following the invasion, if the Germans leave the customary destruction in the wake of retreat of their defeated armies.

Officers back from Italy tell in this issue of the damage to electric systems caused by gun fire and enemy demolition squads and of the reconstruction to supply essential service. One thing that impressed them was how little was the absolutely essential, but more than that how essential that minimum is.

We have wondered after listening to these officers how much this minimum essential service differed as between countries and places within one country. Would we have the same minimum in this country, for instance, as they have in Italy? It is difficult to answer because at once we are confused by so many uses that to us seem so important at least for the present time.

However, several places in this country have gone through hurricanes or floods or ice storms where it has been necessary in service restoration to make a determination of basic necessity. The essentials are always the same—they are the services necessary to public health and public safety. The water supply, sewage disposal, hospital service, fire and police protection—these are the basic essentials.

Beyond the point of minimum essentials for human existence we begin to get differences which indicate the relative livability of nations and of communities. Services other than bare minimum become essential to better living standards, to greater happiness.

We have seen utilities and communities they serve compared by rates. Sometimes we wish they could be compared by the service enjoyed—by the degree to which more service has been essential. That in fact is the criterion in the future by which a public is going to measure its utility—not by the rate it charges but by the degree to which it has improved local standards of living through the greater use of electric service.

There will be certain competitive conditions that will make it difficult for every community to enjoy equal advantages in the fuller use of electric service, but there can be little justification for low usage where cheap competitive services do not exist. If electric utilities want free enterprise, they must be ready to accept the responsibilities of freedom, one of which is to do everything they can to give people living along their lines the opportunity to enjoy as much of the good things of life as the people of any other community.

Minimum essentiality levels all communities to the existence needs of an emergency. Maximum essentiality elevates communities to ever higher scales of living and greater freedom from inconvenience. With that role electric service can gain any goal it sets.

Restoration of War-Area Utility Power Plants

***Measures applied by Army quickly to recover** partial **operation of damaged system facilities—Men experienced in emergency repairs carry brunt and more are** wanted*

As told by
COLONEL C. M. SPOFFORD and LIEUTENANT COLONEL WALKER L. CISLER
to
ARCHER E. KNOWLTON, Associate Editor, "Electrical World"

POWER PLANTS and lines can be discouraging looking tangles after being pounded by the shells and bombs of two opposing armies. They look even more like nightmares when enemy demolition squads have added their worst. Debris and wrecked equipment are everywhere and nothing looks hopeful—to a layman. But when officers of the engineers and special services move in, they eye the scene calmly and critically. With little, if any, of the normal repair equipment available for repairing damage to similar facilities back home, they size up the situation and organize their program of restoration. They know they must achieve quick results, that there are no tie lines to healthy systems, very few parts or spares and only scanty supplies of materials to draw upon.

There are no supernatural procedures to draw upon and consequently there is no legerdemain or mysticism in the measures employed. The measures might appear somewhat magical. But a utility engineer versed in after-storm restorations, on seeing the repair jobs, would conclude that the tricks employed have much of the flavor of familiar tactics used when wind, fire and flood have wrought havoc with plants and lines in peaceful areas. The difference is one of comprehensiveness, of improvisation, of speed and unconventional patching. It is natural for engineers and operators at home, knowing how easily equipment can be damaged by careless operation or handling, to feel that enemy demolition forces can so completely put a plant out of action as to be useless for months. Such is not the case; at least it has not been the case in North Africa and southern Italy. Power facilities were undamaged in Sardinia, and those in Sicily suffered only from combat. Fifteen Germans worked 10 days to demolish a switching and synchronous condenser station. Parts of it were back in service in approximately three weeks. How were such things accomplished, the question was asked. Before taking up details it is desirable to discuss some of the background factors.

FIG. 1—German demolition parties worked this damage on a switching station adjacent to an Italian hydro plant as the allies moved north in Italy. Note the camouflage on the overturned oil switches in the foreground. Biggest difficulty in repairing these switches is to obtain replacement porcelain bushings. To the right rear are transformers which escaped with relatively light damage due to the protection of the heavy masonry stalls in which they are mounted. Part of the switching set-up in the background was returned to service very shortly

In the initial hours after enemy forces have been driven out, the immediate electrical requirements of our own forces in the cleared area are supplied by the U. S. Engineers through the medium of portable generating sets of about 1½ to 50 kw. As more area is cleared more such sets

nd larger ones are moved in. But, eanwhile, the restoration of the local acilities is being instituted. Speed is mportant but complete restoration is eldom the need or the duty of the rmy officers because partial restora- ion suffices for military purposes.

In addition to the provision of ower supply for strictly military pur- oses it is necessary that order be re- tored in the community and that here be no epidemic or famine and inimum risk of conflagration. Power therefore needed for pumping water nd sewage, for grist mills and for re- rigeration of perishable foodstuffs. limited amount of lighting is anted for military and essential mmunity purposes. General restora- on of service to habitable homes and mmercial enterprises is a matter for e authorities charged with later re- abilitation of the reoccupied terri- ries.

An example of the ingenuity which stores power rapidly was the use of ree Italian submarines to furnish e first power in Naples. The three aft, each with a 220-volt d.c. gen- ator, were connected in series and bles run to a tramway cable line. is in turn was connected to a tram- y substation in which a 1,000-kva. nchronous motor d.c. generator set s used in reverse, establishing 9-kv. rvice to important water pumping tions.

Appreciable thought is given to the g range rehabilitation of the fa- ities, at least to the extent of doing ngs that will manifestly not be in- mpatible with the final complete

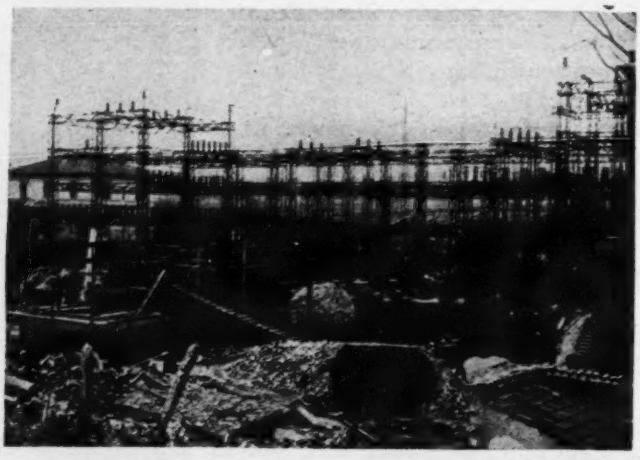
FIG. 2—The rubble in the foreground was an Italian generating station with two medium-sized hydro units before the Germans retreated. The generating plant was a total loss, but considerable salvage was possible on the switching station behind it. The white building (rear center) is not part of the station, but the dark building before it (right middle) is the station transformer repair house

restoration. All things equal, whatever will later facilitate the full re-establishment of the plant is done provided it does not impede the immediate military needs.

Manpower Assembled

U. S. Army, and Royal Engineers as well as naval engineers of both fleets assist and direct the early stages of restoration. In their ranks are men experienced in electric utility operation and manufacturing. In addition, there has been made available a list of several hundred men experienced in emergency rigging and restoration who are already in the armed forces. These, plus others who were specially classified at induction, were detached for service under the engineers. The credit for the prompt restoration of the damaged systems belongs to the engineers.

Help is also obtained from the native plant forces. The key men usually report voluntarily and others are sought. The owners are also found and give advice about distinctive details; they give clues to repair shops and warehouse stocks. In some in-



. 3 (left)—This is what the Germans left of a medium-sized hydro-generator after retreating north in Italy. The rotor is shown e foreground, the stator, its frame cracked and broken beyond repair, behind it. It is estimated that as many as five or six olition charges were used on the stator frame. Twenty Germans worked six days to prepare this plant for its destruction . 4 (right)—The Germans who blew up this hydro plant as they retreated north in Italy found it considerably easier to destroy the erating plant than to level the switching station beyond it. The debris in the foreground is what they left of the plant

FIG. 5—This boiler in a Naples steam plant was blown from its foundation by retreating Germans and plunged downward through a reinforced concrete floor, but it was far from being totally unusable. Note the position of the boiler drum with relation to that on the boiler to the right, which remained on its base. This boiler probably could be repaired locally without the necessity of importing more than tubes, since the drum, the header and most tubes were left in physically sound condition

stances the operators had disappeared, possibly German prisoners.

Machine shops, foundries, jobber warehouses, sheet and structural steel yards have been located and contacted. Usually these are eager to get back into functioning but can hardly make much progress without electric power. Consequently they usually prove equally eager to supply the materials and parts which are indispensable for the first steps in repairs. It takes much ingenuity to stretch the facilities of these plants and to adapt the stocks they may have on hand. Once a couple of key small industrials have been got going the recovery accelerates.

Seek and Find

It is surprising what can be rustled up from these repair shops and warehouses in terms of rods, bars, plates, structural shapes, tubes and castings that can be adapted. In Italy the Germans seem not to have carted away everything metallic as they are reported to have done elsewhere. However, it usually takes considerable amounts of the proverbial American push and technical cleverness to convince the proprietors that unorthodox things can be done and will work. American versatility is half the answer in repairing what the orthodox-minded European has tried to wreck.

Dexterity, resourcefulness, ingenuity, contentment with results short of perfection or totality and "cannibalization" are prime factors. Cannibalization is the word coined by the military men to mean using parts of several damaged equipments to assemble a whole workable unit. It is what the British did with tanks to turn Rommel back after he and the world thought they were licked at Alamein. It is done every day with the planes. It is proving a large part of the answer to the problem of putting electrical systems back into partial service.

Extent of damage done by demolition squads is approximately proportional in bulk to the time in which they are allowed to do their work. In the area north of Naples it has been found more extensive than in the areas to the south and across the Mediterranean. The Germans moved out of the foot of Italy fairly fast but they had a little more time to organize demolition after retiring to a line roughly 40 miles south of Naples.

Explosives are the primary means of destruction. Penstocks may be damaged but welding recovers them. Bent shafts may be straightened. The steel work is often usable. Cast water boxes to repair the condenser have been made in local foundries. Many types, but not all, of castings have been obtainable, but pressure has to be applied to convince the foundries that large ones can be handled by them. Forgings can be obtained only from limited stocks of available finished forms.

Margins for Recovery

Most of the electrical equipment are damaged while in unenergized condition. In one plant, charges e

FIG. 6—This undamaged Brown-Boveri 15,000-kw. steam turbine was one of three a Naples generating station. Governors were blown off the other two turbines, on which may be seen to the right. New governors were made locally

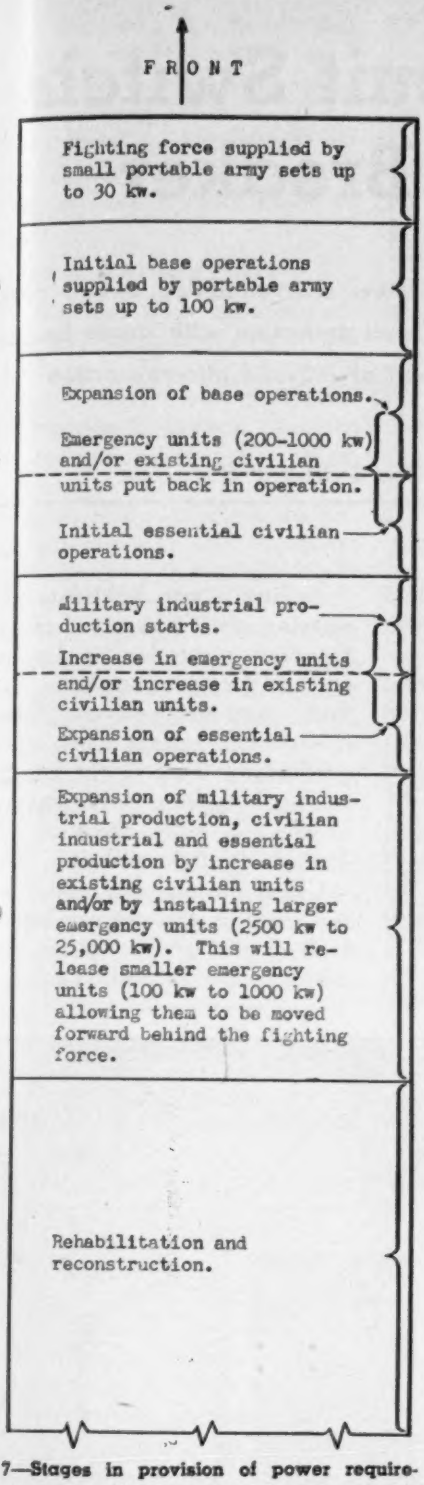

FRONT
D
Fighting force supplied by small portable army sets up to 30 kw.
D+10
Initial base operations supplied by portable army sets up to 100 kw.
Expansion of base operations.
D+30
Emergency units (200-1000 kw) and/or existing civilian units put back in operation.
Initial essential civilian operations.
Military industrial production starts.
D+90
Increase in emergency units and/or increase in existing civilian units.
Expansion of essential civilian operations.
D+150
Expansion of military industrial production, civilian industrial and essential production by increase in existing civilian units and/or by installing larger emergency units (2500 kw to 25,000 kw). This will release smaller emergency units (100 kw to 1000 kw) allowing them to be moved forward behind the fighting force.
D+180
Rehabilitation and reconstruction.

FIG. 7—Stages in provision of power requirements in communications zone beginning with D-day of invasion

ploded only on two of the three turbine governors. The undamaged governor served as a model for making the two replacements.

One factor of assistance in connection with both plants and substations has been the practice of the Italians in providing much larger reserves than has been American practice even before the war. This leaves margins in individual plants and offers excellent opportunity to shift units and auxiliaries from plant to plant and thus obtain the modest amount of capacity which is required for immediate military needs. Peak load equipment in one place may serve base load needed in another. Unfortunately, the Italions had not kept all equipment —particularly steam—in the best condition during the stress of their preceding-war years.

A helpful factor in the Allied rehabilitation successess is that several of the Italian electrical manufacturers are affiliated with American or British concerns and follow much the same philosophy of design and engineering layout.

"Odd" Frequencies

Frequencies and voltages are different from the American standard 60-cycle pattern. Frequencies of 42, 45, 50 and $16\frac{2}{3}$ (mostly railway) are prevalent. When any effort is made to use 60-cycle equipment it has to be adapted, outputs are reduced, speeds have to be adjusted or accepted as different, governors and field rheostats have to have a wider range than is commonly provided. This affects particularly the effort to get small and moderate sized Diesel units to help meet the immediate emergencies. Output transformers have to have more taps in order to establish the requisite delivery voltages.

Substations are mostly of the indoor type, even for higher voltages, and the equipment is quite thoroughly incapacitated by the wreckers. Transformer tanks and radiators have been pierced but in some cases the coils were found practically intact; what it took was mostly a replenishing supply of oil. In other cases the coils were found cut and damaged. Bushings of transformers and breakers are vulnerable to artillery fire and are proving one of the deterrents to quick restoration of output; no appreciable stocks have been found. Fortunately some of the bushings have escaped demolition. Bus-bars are often warped and disrupted but straightening and reattachment are not difficult tasks. Switching equipment is most often restored by "cannibalization." No sizable stock of parts was found for switchgear and consequently much shifting and improvisation is resorted to in restoring the system.

Transmission

Transmission presents fewer problems. Most of the damage here is the result of two-sided artillery fire. The injuries are spasmodic in occurrence, whole stretches of good line being found between damaged sections. Towers are often reparable or new ones can be improvised from available structural pieces. Conductors are merely spliced together with Crosby clips, which can be made locally. The Army also has them. It is not strange to have a line working adequately with several such splices between supports. Sections of missing conductor can be made up by robbing an unimportant line. Considerable stocks of cable and conductor are found although the Germans did haul away large quantities of fully fabricated cables. Often heavy equipment has merely been toppled over by explosives and can be righted and restored to service.

Much of the urban distribution is along walls or over roof tops. There are relatively few wooden poles and many more concrete poles than are common on the North American continent.

Greater Destruction Ahead

Depending again on the time available for destruction, plants may or may not be so completely devastated as to be out of service for long periods of time. So far the delays in restoration are not nearly so long as would be required to get wholly new equipment made, delivered and installed. If the south countries are any criterion, the situation in the north countries may present more thorough destruction, if the Germans are given the time, but the repairs are not likely to be any more difficult or the delays any longer than the relatively short ones around the Mediterranean in terms of the long range restoration. For the immediate situation, the rehabilitation measures will be largely the same, as now foreseen, as have already been applied. The plants in

the north will be much closer to the British factories both for supplies and replacements and this will offset any risk of more comprehensive demolition. One handicap in the South Italy picture is that the heavy electrical and other manufacturing plants are largely in the northern tiers still under control of the enemy.

Now there are no new generators, no spare fields, no spare condensers in the part of Italy released from enemy control. In the end the civilian rehabilitation forces will probably have to import such equipments from the Allied countries. One cannot do more than provide emergency supplies by a wide-scale robbing of Peter to pay Paul. No such shipments of assembled equipment or even of major parts are contemplated while the task is in the hands of combat and service forces.

Technical Men and Materials

What is needed right now for repair activities is manpower. The technical personnel now on the scene have their hands full. They must be augmented in Italy and more must be assembled for the new invasion areas. More men with the experience indicated will be needed. It is recommended that they do not volunteer but await their call and then be sure to tell classification officers that they have had experience in emergency restoration of electric utility plants and lines.

Mostly what is needed in materials at the moment is a stock of supplies and parts—tapes, solder, acetylene, varnish, welding rod, mica, compounds, gasket materials, turbine blades—the usual run of facilities which the maintenance man draws upon. In particular, they differ from those required for routine maintenance only to the extent that rehabilitation of extensively damaged equipment differs from merely keeping apparatus healthy. Metallic parts can usually be welded, patched, straightened, spliced or recast in good working order.

Plants which have borne the brunt of demolition squads are, as said at the outset, likely to look dismally hopeless but restoration is essentially a matter of repairs and repair materials ingeniously coupled with improvisation and resourcefulness of the kind that does unorthodox things successfully.

Short-Circuit Switch in Lieu of Breaker

Automatic 115-kv. short-circuiting switch provides transformer fault protection with single breaker at the source end of 105-mile interconnection

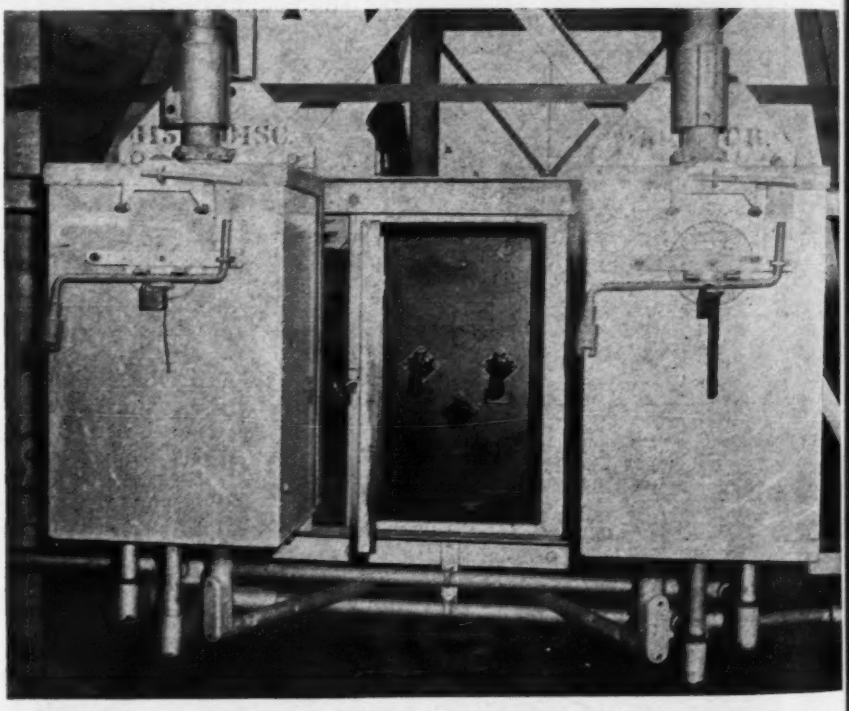
JOS. F. SINNOT, San Diego Gas & Electric Co.*

WHEN the 105-mile, 115-kv. tie line between the San Diego Gas & Electric and Southern California Edison systems was being contemplated several protective schemes were considered for the three-unit, 36,000-kva. transformer bank at the San Diego end of the line. Transformers are 115/66 kv., wye-delta with grounded neutral and are equipped for remotely controlled tap changing under load in the ground end of the high-voltage windings.

*Protection Engineer, San Diego, Calif.

At first it was decided to rely on relaying at the Edison end of the line for fault protection as far as the 66-kv., low side breakers. Careful fault current analysis, however, showed that certain types of faults, particularly those in the tap changers, would develop insufficient current to effect a relay operation of the breaker 105 miles distant.

Called for was differential protection for the transformer bank, low fault current protection for the tap changers, and protection for ground



HOUSINGS for motor mechanisms (left and right); control switches (center panel) for operating 115-kv. switches electrically but non-automatically; removing the hand cranks and inserting them in the mechanism opens a safety switch, removing the automatic feature; for "hold-out" orders on the line the metal collar above the mechanism housings is lifted and padlocked, completely disengaging the operating rods

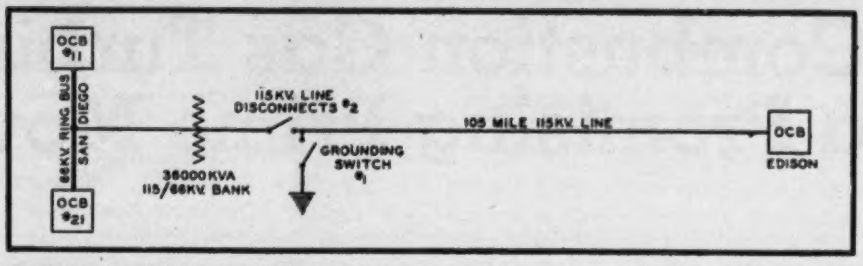
faults on the 66-kv. windings which were to be delta connected to a grounded wye system. This would seem to indicate either a 115-kv. breaker at San Diego, carrier current relaying, or some type of pilot wire tripping, any one of which would be expensive.

Short Circuiting Switch

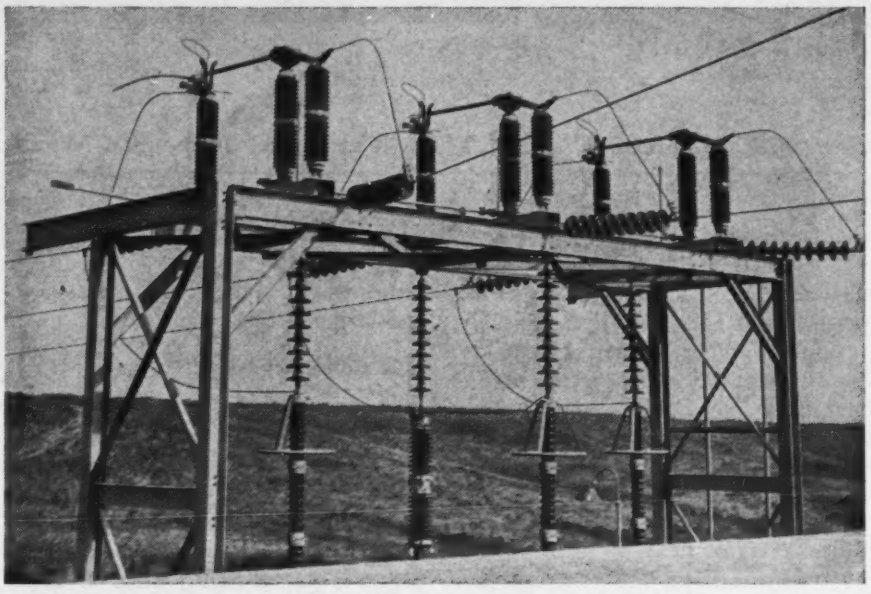
For economy sake an automatic 115-kv. short-circuiting switch was decided upon. This switch would ground all three phases of the 115-kv. line at the San Diego end after the 66-kv. breakers there had opened, with provision for grounding one phase about 15 cycles before the two others in order to permit the faster and more sensitive ground relaying at the far end of the line to function. Throwing a three-phase fault on the 115-kv. system was not deemed intolerable inasmuch as the three-phase fault kva. for faults at San Diego from the north was not too greatly in excess of full load kva.

Final installation, which has now been in service nearly three years, consists of two sets of automatically actuated, motor-operated disconnecting switches. The line disconnecting switches are rated at 132 kv. and are mounted on post-type insulators, and the grounding disconnects merely close against contacts on the line end of the line disconnects. The arcing horn on one phase of the grounding disconnects is about 2 ft. longer than on the two other phases in order to obtain the 15-cycle advance operation.

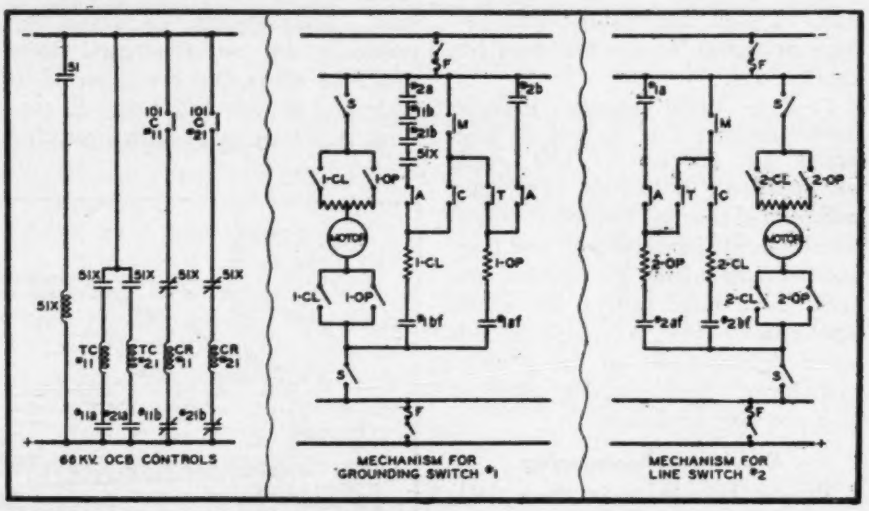
Operation is as follows: (1) A fault develops in the protected zone actuating the relays. (2) This trips the 66-kv. breakers and opens their closing circuits through a hand-reset tripping relay. (3) When the 66-kv. breakers are both open, the motor-operated grounding switch closes. (4) When the grounding switch is closed the 115-kv. line disconnects between the bank and grounding switch open. (5) As soon as the line disconnects are open the grounding switch reopens to re-establish carrier communication over the de-energized line. Sufficient time interval has elapsed to permit the breaker on the Edison end of the line to clear long before the grounding switch reopens. An elementary diagram showing how this control is obtained is shown in an accompanying illustration.



ONE-LINE DIAGRAM of 115-kv. tie between San Diego Gas & Electric Company and Southern California Edison Company



DISCONNECTS (closed) and grounding switches (open) used in transformer fault protection scheme; extended arcing horn on left phase short circuits this phase 15 cycles before the two others



ESSENTIALS of transformer fault protection

51—Protective relays
51X—Auxiliary hand reset relay
TC—Trip coil
a—Auxiliary switch closed when breaker or relay closed
b—Auxiliary switch open when breaker or relay closed
af—Auxiliary switch closed when disconnects fully closed
bf—Auxiliary switch open when disconnects fully closed
101C—Control switch to close OCB
CR—Closing relay
S—Safety switch, open when hand crank is attached
A&M—Contacts of manual automatic switch
C&T—Contacts of control switch
OP&CL—Opening and closing contacts and coils for motors

Combustion Gas Turbine a Promising Prime Mover

Attractively high potential efficiencies at high temperatures hardly attainable in large units until appropriate metals are available, economically justifiable refinements perfected, and use of coal as fuel substantiated

S. K. FISCHER and C. A. MEYER†, Westinghouse Electric & Manufacturing Co., South Philadelphia, Pa.*

THERE ARE many future uses of the gas turbine because it potentially promises higher efficiency at very high temperatures than most engines and prime movers used today. Future applications range from electric power generation to the power plants for propelling airplanes, trains and ships.

Advantages of the gas turbine cycle as compared to the conventional steam system include: (1) no boiler is used; (2) water is not required for the simple open-cycle system; (3) promises greater efficiency improvement at high temperature, and (4) high hp.-per-lb. output for short life applications.

Present disadvantages include: over-optimism; fuel limited to high grade oils instead of low grade oil and coal; little field experience and need of time to complete technical developments in metallurgy and component parts of the gas turbine system. To a large degree, the future application of the gas turbine depends upon developments in the field of metallurgy, aerodynamics, combustion and heat exchange.

Experience Encouraging

Present knowledge in these fields permits building and operating simple gas turbines for certain purposes. Experience with some of the simple forms of gas turbine plants has been successful and encouraging. In the post-war period, industry will benefit from the developments now being engineered for national defense. These developments will accelerate the application of gas turbine plants to new and larger fields.

Gas Turbine Is Simple

Progress toward a practical gas turbine power unit has been delayed because the thermal efficiency required to make it competitive with the highly developed steam cycle required: (1) operation above 1,000 deg. F.; (2) a highly efficient compressor, and (3) a highly efficient turbine. Two seemingly unrelated industries have recently made important contributions to help solve these problems. Metallurgists, in developing materials for superchargers, have produced alloys that are expected to withstand at least 1,200 deg. F. continuous service at the low operating pressures encountered in gas turbine work. Aviation and wind tunnel research on airplane wings have contributed fundamental aerodynamic data on which high efficiency compressor designs are based. The research in these two industries plus the accumulated steam experience of many years has made possible the necessary high-efficiency turbine and compressor elements and has solved many of the mechanical problems involved in gas turbines.

Two Types of Cycles

The open-cycle combustion gas turbine eliminates a big and expensive step in providing power to drive generators or machinery. In its power cycle, all the hot gases of combustion

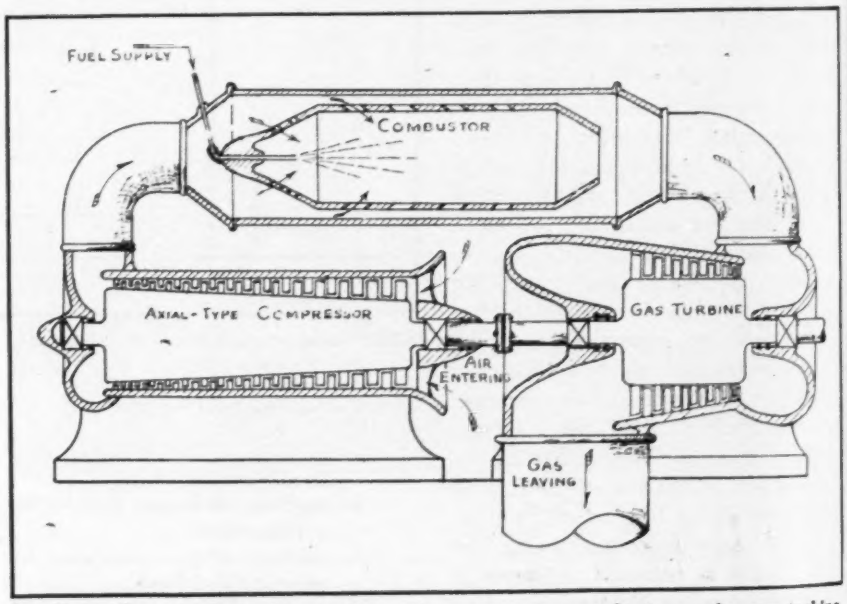


FIG. 1—Elements of gas turbine cycle are: a compressor, a combustor, and a gas turbine

*Steam Engineer
†Development Engineer

go straight to the turbine, thus eliminating the steam boiler. By contrast, in the highly developed steam cycle, the fuel energy must be converted to steam before expending its energy in the turbine. In the combustion gas turbine system of power generation there are two basic cycles—the open cycle for moderate capacities and the closed cycle for very large units.

The gas turbine employs the simplest power cycle known, consisting of three major elements: a compressor, a combustor and a gas turbine. A general idea of what the elements are like is shown as longitudinal sections in true relative size in Fig. 1. The gas turbine resembles the straight reaction, non-condensing steam turbine. Gas turbine blades look more like air foil sections than like reaction steam turbine blades, due to the small pressure drop and large gas volume involved. The axial-flow compressor also resembles a straight reaction turbine, with the gas to be compressed passing axially through the compressor. The action of the blades in the axial flow compressor is the reverse of the action of expansion in a reaction turbine. This physically small compressor handles the large volume of gas efficiently. The combustor is the burner in which the chemical energy of the fuel oil is converted into heat energy by burning the fuel with sufficient excess air to obtain the desired temperature. The hot product of combustion from the combustor is the gas, which, expanding to a lower pressure and temperature in the gas turbine, converts some of its heat energy into mechanical energy at the turbine shaft. The combustor is relatively small since its rate of heat release is many times that of the conventional steam boiler which, in addition to burning fuel must transfer the heat through tube walls to generate steam.

How Cycle Works

The combustion gas turbine open cycle comprises three major elements: compressor, combustor and gas turbine. To start a combustion gas turbine some external means, such as a motor, is required. This is necessary, as the air for combustion is supplied to the combustor by the compressor. When the unit is in operation the energy to drive the compressor comes from the expansion of the products of combustion in the gas turbine.

In the simple open cycle operating at 1,200 deg. F., the products of combustion (gas) contain some 600 percent excess air. This gas is expanded in the turbine and exhausted to the atmosphere. In the gas cycle a compressor and combustor replace the comparatively large boiler, resulting in a much smaller and more compact power plant. The simple open combustion gas cycle does not require a condenser and plants may be located without regard to a suitable source of cooling water.

Although the first patent was taken out over 150 years ago, early inventors were unsuccessful in getting units efficient enough to drive their own compressor.

Metals now available are capable of operating at high temperatures and the maximum temperature employed is largely a question of the useful life. For a life of relatively few hours, such as might be satisfactory for some military needs, temperatures of the order of 2,000 deg. F. are allowable. Heavy duty or long life applications are limited to much lower temperatures. The tremendous advances in metallurgy for the war effort will undoubtedly produce materials capable of operation at temperatures which we would not have attained for many years under a normal peace time development.

Turbine and Compressor Efficiency

In the gas turbine cycle, the useful power output depends upon obtaining relatively high turbine and compressor efficiency. Useful net output is the difference of two fairly large quantities: the total turbine output and the work consumed by the compressor (Fig. 2) in compressing the air. The useful output decreases sharply as the top temperature is lowered.

In Fig. 3 the simple gas cycle thermal efficiency is plotted as a function of the pressure ratio for several turbine inlet temperatures of the combustion gas. Pressure ratio is the compressor discharge pressure divided by the compressor inlet pressure, which is 14.7 lb. per sq.in. abs. in the open cycle. A reduction in compressor efficiency of 9 percent cuts the cycle efficiency almost in half.

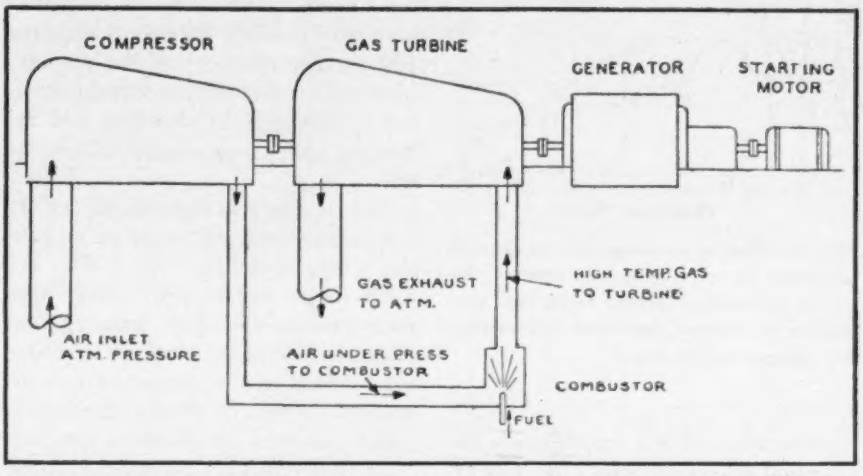


FIG. 2—Simple open-cycle of combustion gas turbine. At top temperature of 1200 deg. F. for each useful unit of power output the turbine develops 3.95 units of which 2.95 are needed to drive the compressor. A reduction of 1 percent in each of these elements reduces the useful output by 7 percent

The gas turbine plants in Europe are inferior in efficiency to what can be built today, but they are apparently giving satisfactory results. Interesting applications include a turbine locomotive, electric generating set, compressor drive for Velox boiler, refinery drives and airplane propulsion.

Efficiency of the simple open gas cycle is low (Fig. 3) unless extremely high temperatures are used. However, there are three practical ways of greatly improving the gas cycle efficiency. They are: regenerating, intercooling and reheating. These are shown in schematic form and in several combinations on another page (84) of this issue.

Reheating and intercooling increase

the amount of useful energy per pound of working gas passing through the system, thus reducing the number of pounds of working medium circulated. Therefore, the size of piping and blade path in the compressor and turbine are reduced. In

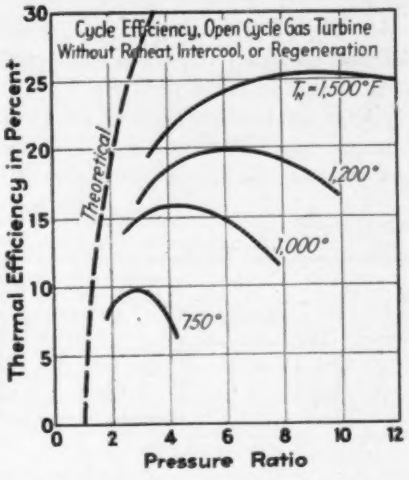


FIG. 3—Effect of pressure ratio on thermal efficiency of open cycle gas turbine. Assumed efficiencies: turbine 85 percent, compressor 84 percent, combustor 100 percent. Air temperature 70 deg. F.

combination with a regenerator, the terminal difference across the heat exchanger is greater for a given size exchanger, or a smaller heat exchanger transfers the original amount of heat. In partial load operation they increase the partial load efficiency by a considerable amount.

Various Cycle Combinations Compared

Thermal efficiency of the open cycle gas turbine for various combinations of regenerating, reheating and intercooling is shown in Fig. 4. This gives the relative values of these modifications and a general idea of possible applications of this cycle. The temperature range of 1,000 to 1,500 deg. F. was chosen because applications at temperatures much below 1,000 deg. will undoubtedly be impractical. Early applications for heavy duty long life apparatus will probably not exceed temperatures of 1,200 with 1,500 deg. F. and higher limits awaiting future developments in metallurgy.

The temperature of the inlet air to the compressor has a marked effect on the cycle efficiency. In contrast to steam plants the colder this inlet air, the higher the cycle efficiency and capacity. In the simple open cycle, changing the inlet air temperature 10 deg. F. changes the cycle efficiency 0.74 points or approximately 3 percent per 10 deg. F. change. The effect on capacity is approximately 4 percent per 10 deg. change.

Steam and Combustion Gas Cycles

Comparison of the steam cycle and the gas cycle may help in judging the gas cycle and its possibilities. The best any cycle can hope to do, when operating under the same conditions, is to attain the Carnot Cycle efficiency. The gas turbine cycle can theoretically give the same efficiency as the Carnot Cycle. This is only theoretically possible because it requires 100 percent efficiency of the gas turbine and compressor, an infinite number of stages of intercooling and reheating and a regenerator infinite in size.

The steam cycle theoretically offers the Carnot Cycle efficiency only up to the critical pressure (705.4 deg. F.; 3,206 lb. per sq. in. abs.) Above this temperature, the gap between the steam cycle and the ideal cycle gradually widens as the temperature is increased. From a purely theoretical standpoint the combustion gas turbine cycle holds forth greater promise of efficiency than the steam cycle.

Of more value are the thermal efficiencies obtainable in practical applications. Fig. 5 compares the best efficiencies obtained in large central station power plants (projected to 2,000 deg. F.) with the expected practical limit in efficiency of the large capacity closed cycle combustion gas turbine power plants. Above 1,000 deg. F. the gas cycle efficiency increases approximately three times as fast as the steam cycle efficiency for a given top temperature increase.

It is expected that the gas turbine cycle efficiency will not be greatly affected by unit size, and this combustion gas cycle curve can also be interpreted as applying to open-cycle gas turbine power plants of relatively small capacity. Economic steam plants for capacities around 5,000 kw. seldom exceed 25 percent over-all thermal efficiency. This would indicate a considerable efficiency advantage, in small units, in favor of the gas cycle, provided economics permit designing it for anywhere near its maximum possible efficiency.

The closed cycle offers a method of increasing the maximum capacity of the open cycle. In it the circulating working gas is at a relatively high pressure and reduces the physical size of compressor and turbine. To reduce the temperature of the gases before they enter the compressor, cooling water is required in the closed cycle. The heat exchanger in which the gas is cooled before it enters the compressor is called a gas precooler. The amount of heat given up to the cooling water is equivalent to that removed in the condenser of a steam unit of equal capacity. The quantity of cooling water required will be less, as a higher water temperature rise is permissible.

Closed Cycle for Large Units

In the closed cycle, the compressor inlet pressure will be maintained at approximately 150 lb. per sq.in. with a discharge pressure of some 600 lb. per sq.in. This high pressure greatly reduces the size of turbine and compressor and should permit maximum ratings to be built approaching those in the steam cycle. Some gas other than air may be used as the working

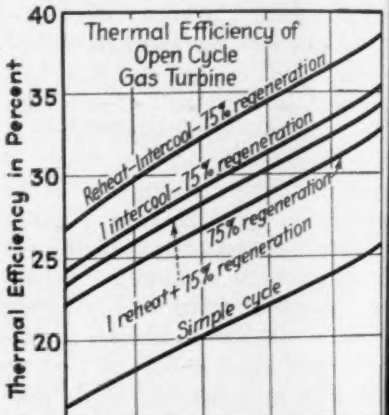


FIG. 4—Effect of reheat, intercool and regeneration on thermal efficiency over range 1000 to 1500 deg. F. Based on 70 deg. F. and 5 percent pressure drop in regenerator. Assumed efficiencies: turbine 85 percent; compressor 84 percent; combustor 100 percent

medium in the externally fired closed cycle. Hydrogen, for example, has properties which make it far superior to air for this application. The density of hydrogen is 1/14 that of air the specific heat is 14 times that of

air, and the thermal conductivity is 6.8 times that of air.

New Cycle Studied

A closed-cycle system is under development by Westinghouse. In this closed cycle a separate gas turbine and compressor are used to pump up the cycle on which the main gas turbine and compressor operate. High pressure of around 600 lb. per sq.in. may be used with a compressor inlet pressure of around 150 lb. per sq.in. The main gas turbine and compressor would be small as they operate at high pressure. This cycle is internally fired, the products of combustion passing through the gas turbines and main compressor. Enough make up air is continually supplied to maintain pressure and support combustion. It is supplied by a compressor which is driven by a second gas turbine. This cycle avoids the large gas heater required by the Escher Wyss cycle; but requires an extra gas turbine and compressor to pump up the system. Solid matter from the fuel must be removed.

Reheating and intercooling offer the same advantage in the closed cycle that they offer in the open cycle. The biggest single additional problem in the closed cycle is a method of building practical heat exchangers. The problem is further complicated by the fact that the gases will carry foreign matter from combustion which may both corrode and erode the exchanger and reduce the heat transfer rate by depositing foreign material on the transfer surface.

Possible Applications

Possible applications of the gas turbine are many. Ranging from a simple open cycle for small capacities to a closed cycle for very large ratings it offers wide possibilities. For example in the order of likely practicability these are: locomotives, airplanes, ship drives, power and processing.

General application of the combustion gas cycle in the power generation field will probably not take place until the problems in connection with the use of coal as a fuel are solved. Successful development of the closed cycle is necessary if units of very large capacity are to be built. The maximum capacity for which units can be built in the open cycle will include the majority of industrial applications. There are many special applications in the power generation field in which the open gas cycle will possibly find early application. Examples are: emergency standby service, and low first cost units on the ends of transmission lines. Here a simple open gas cycle offers many advantages, such as no water required, low first cost, simplicity, small space requirements, and virtually automatic station with few attendants.

In the industrial field where both power and process steam are required, the gas turbine has possibilities. It fits well in those applications where the steam required is relatively small in relation to the power load. This is different from the extraction steam turbine where large quantities of process steam per kw. are necessary to attain a comparably efficient cycle. Here again, the use of coal as a fuel is necessary for a wide application.

Many Problems Ahead

In drawing conclusions, it should be remembered that the cycle has only had practical application in very special cases. Full possibilities of any cycle can only be evaluated from successful proof of its economy, first cost, maintenance cost and reliability. Addition of elements which improve the fuel economy, and arrangements of the cycle for large capacities, are obtained at a sacrifice in simplicity and at a price. Development of the best system is expected to be costly in time and money.

Metallurgy plays an important part in the gas cycle as the efficiency increases rapidly with increase in top temperature. Metallurgists are looking at materials similar to the non-forgeable and non-machinable tool steels. The method of forming these alloys to shape, such as precision casting to size, may revolutionize accepted methods of manufacture. To apply such materials, their additional first cost and manufacturing cost must be justified. Any application of such materials must be preceded by careful tests. For heavy duty apparatus these tests must extend over long periods before the designer can use them with safety. Careful differentiation between applications as to required length of life of apparatus is necessary. The fact that a piece of equipment is operated at 1,800 deg. F. for a life of a few hours does not mean temperatures of that order can be used for heavy duty applications.

Present developments of the gas turbine are limited to the use of relatively high grade fuel oils. This one factor is a serious handicap to the gas cycle. There is considerable evidence that oil is being used at a greater rate than new supplies are being found. So in the post-war period necessity may dictate a prime mover which can use coal as a fuel. The gas cycle is definitely limited in application until such time as the problems in connection with the burning of low grade oil and coal are successfully solved.

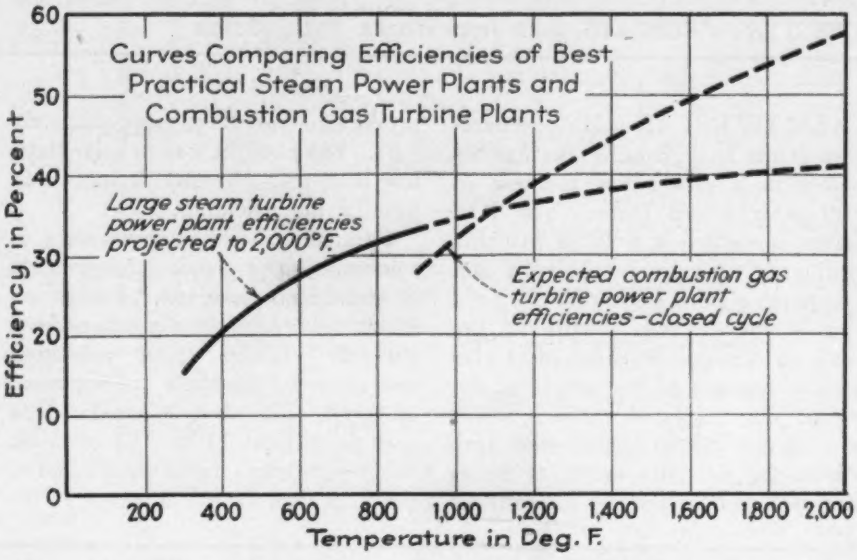


FIG. 5—Efficiencies compared for best practical steam power plants and combustion gas turbine plants

More Production Obtained by Paralleling Welding Machines

Slight revisions of separately excited motor-generator type of welder units and provision of protective equipment allow parallel operation

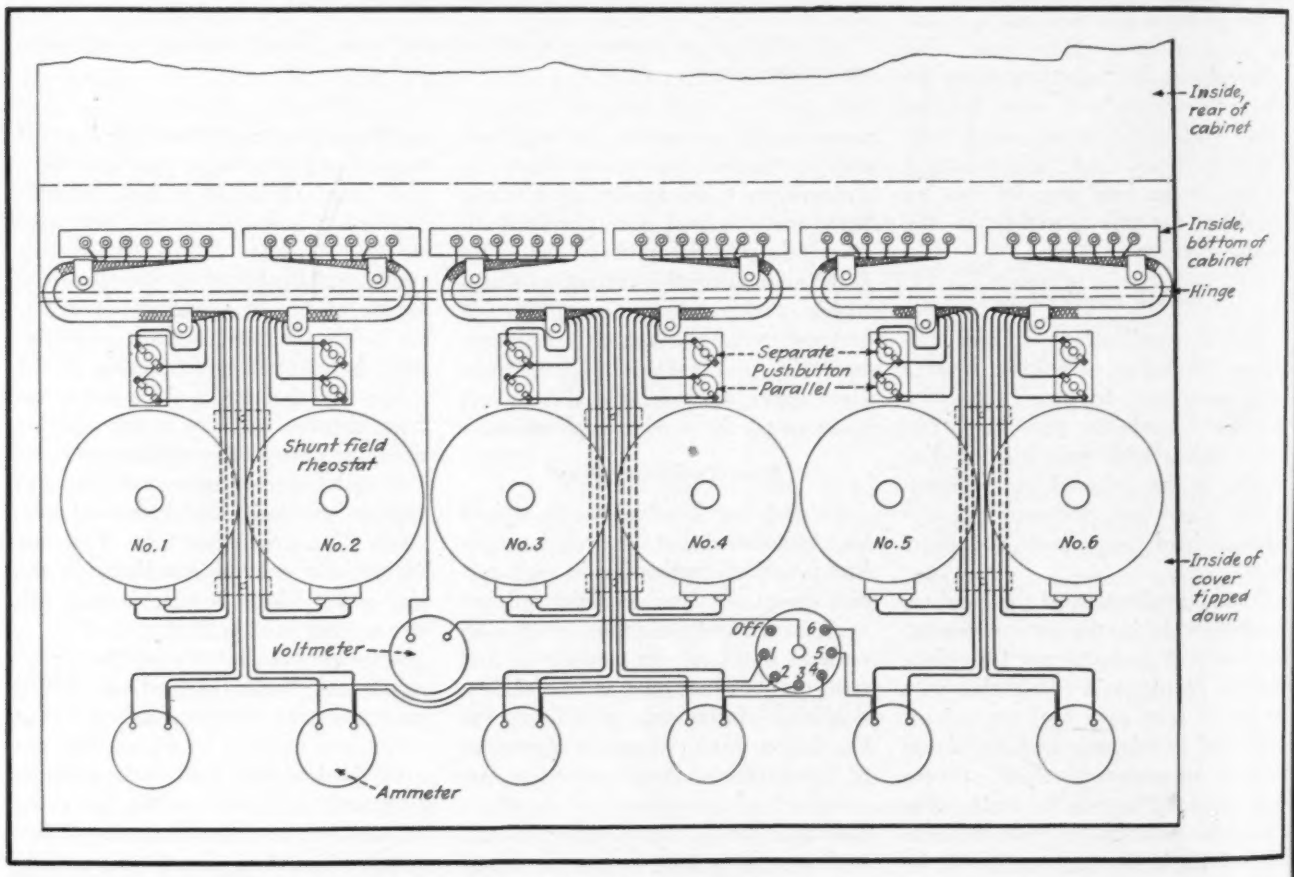
CHESTER A. ROBERTS, Bath Iron Works, Bath, Maine

PARALLELING of welding generators at the Bath Iron Works has resulted in a production increase of 100 percent and more. The load factor on which a welding machine ordinarily operates in shipyard and comparable work is characteristically low. The diversity factor of the load on a single machine must also be low because of the nature of the work. In tacking operations which are extremely intermittent, tests have shown the diversity factor to be as low as 5 and for the less intermittent production welding, approximately 1.67. The obvious way to raise these low load and diversity factors is to parallel the machines.

Paralleling welding generators is something most people think can not or should not be done. Poor commutation, evils of over-compounding, general balkiness, poor operation and harm to machines are supposed to result. However, it can be done and the difficulties can be avoided. What paralleling has accomplished at the Bath Iron Works is shown in the accompanying tabulations indicating production increases and cost savings.

The method of paralleling is shown in the schematic diagram. It is different from what ordinarily would be expected in that three, instead of two, buses are used. This is to allow shunt connection with each other of armatures and series and interpole fields. Also the welder leads are not taken from the bus, but from each machine individually.

Before a machine is paralleled its field compounding is changed from



SINGLE-PANEL assembly of controls and instruments of paralleled generators

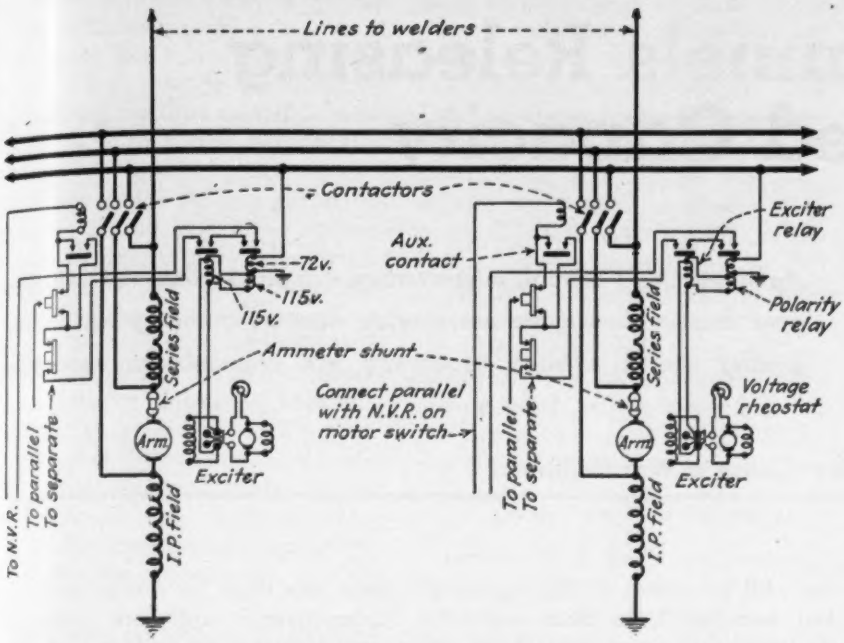


DIAGRAM OF SCHEME for paralleling welding machines. Only two generators are shown but the connection can be extended indefinitely. Experience has shown that most satisfactory results are obtained when the capacity of each welding line is taken as double the capacity of the machine to which it is connected. Bus conductors should be of current capacity equal to one machine

differential to cumulative. Brush positions are checked and set at exact neutral points.

Automatic protection is provided against loss of power to the drive motor, loss of exciter voltage and polarity reversal. If a generator goes dead by any cause it drops off the paralleling bus, taking with it the welder line it was feeding. This arrangement gives instant notice of machine trouble and also allows the use of a smaller contactor for making the parallel connection, than would be needed if the welder line were taken from the bus. The contactor in this case is a 3-pole, 220-volt, a.c. unit with its solenoid connected in the a.c. motor supply circuit.

Exciter failure is protected against by a 115-volt relay across the exciter circuit which drops out and opens the paralleling contactor if voltage fails. Another relay with its contacts in series with the first has two coils, one wound for 115 volts and connected across the exciter circuit, and the other wound for 72 volts and connected across the generator output. In normal operation the fields of these two coils are additive and hold the relay closed. But if the exciter polarity reverses, the two fields oppose each other and the relay contacts open. The contactor and the relays are Allen-Bradley, the contactor No. 702, size 3 and the relays No. 200. The polarity relay is revised by replacing the standard 115-volt coil with the two described. A standard "Start-Stop" push button is included in the control circuit to parallel and disconnect the generator on the bus.

The controls, ammeters, voltmeter and field adjusting rheostats of the generators to be operated in parallel are centralized on one panel.

On most welding machines the ammeter shunt is connected in on the load side of the series field. It is to be noted that in the diagram the shunt is between the armature and the equalizer bus. The reason for this change is that in parallel connection the current in the series field does not necessarily represent the load on the generator, but the load is represented by the current through the armature. Part of the current in the series field may be coming from other machines through the paralleling bus.

In a test of the parallel connection two 600-amp. machines were started separately. One was loaded to 450 amp. at 84 volts. The other ran with no load and with 70 volts across its terminals. Then the two were paralleled. No bucking, no excitement. The low potential machine went right along with zero load and the other with its 450 amp. The field rheostats were then adjusted to divide the load equally, and energy to one driving motor was cut off. The generator of that machine motored with 30 amp. through its armature and the potential dropped 10 volts on the other machine. In another test ammeters were connected in the equalizer buses while a typical welding load was carried. The ammeters showed continual and rapid changes in direction and magnitude of bus currents indicating that each machine was doing its required part in carrying the common fluctuating load.

More welding production from a group of machines is the prime object of paralleling. But there are other advantages, too— better regulation of welding voltage and thus better welds, improved efficiency in operation of driving motors, space saving and conservation of labor and materials otherwise required for additional welding machines.

Man Increases by Paralleling Welding Generator

	Separate Operation	Parallel Operation	Increase
Two 600-amp. unit			
Tackers	16	35	19
Welders	6	12	6
Six 400-amp. units			
Tackers	24	60	36
Welders	12	24	12
Five 300 amp. units			
Tackers	15	40	25
Welders	5	15	10

Estimated Savings by Paralleling Welding Generators

Number of machines paralleled	30
Normal load—men tacking with paralleled machines	282
Normal load—men tacking with single machines	118
Man increase from same equipment paralleled	164
Equivalent machines saved	42
Machine cost saved	$18,900
Machine housing cost saved	4,000
Power supply feeder and distribution saved (A.C.)	7,000
Welding distribution cost saved	4,500
Overhead cost saved	6,000
Initial saving	$40,400

Note—The cost of material and labor for paralleling 30 units was $3,000. A yearly saving of $15,140 is estimated based on depreciation of machines and welding sheds, floor area conserved, maintenance of building and equipment.

Carrier Channels Releasing Much-Needed Capacity

Automatic load control, telemetering, communication and relaying over carrier have made nation-wide wartime gains by facilitating greater use of existing generating and transmission capacities

G. A. GRIMM, Principal Power Analyst, Office of War Utilities

BEFORE Pearl Harbor utility systems, both isolated and those in interconnected groups, were engineered and built to the best economic standards, with little fear that the materials could not be obtained. After that "sneak attack" the design and operating problem took on an entirely different aspect. Vast amounts of basic materials used by electric systems were needed for the armed services. Copper, aluminum, brass and steel were immediately unobtainable. At the same time the demand for electric power skyrocketed. Where only a few short months before a request for service for 5,000 or 10,000 kw. demand gave lots of companies considerable concern, now they were getting requests for 30,000 to 50,000 kw. or more, and instead of 40 or 50 percent load factors, the new loads were going to be on the order of 90 to 100 percent load factor. War, with its requirements of vast amounts of high-octane gasoline, aluminum, magnesium, synthetic rubber and alcohol, the rapid expansion of maritime and combat vessel production and heavy armament, as well as small arms ammunition, was calling on the utility industry for vast quantities of additional power. It was immediately realized that the industries creating this demand were going to need equipment made by the same manufacturers that would produce the generating equipment with which to carry the load. The engineers were faced with designing system capacity of magnitudes seldom encountered before and with practically all of the habitual materials becoming very scarce. The industry and the country can well be proud of the ingenuity and resourcefulness their engineers showed in meeting this challenge. Had these men failed, the newspapers would be printing vastly different stories today.

System designers were faced with the task of providing facilities for new war loads. Time was going to be required to build manufacturing facilities, which also permitted time to design the electrical systems. But the operating engineers were faced with a different problem, that of providing immediate capacity for the sudden demand of established loads that almost over night exceeded all previous amounts. To take care of this increase meant that old equipment had to be used to its fullest capacity. The quickest way of stepping up production of war materials was for the manufacturer to us his machinery and facilities to the fullest extent, which required around-the-clock operation. This meant to the utility operating man that there was going to be little available time for him to take badly overloaded equipment out of service for maintenance. It was fully realized that this condition could not go on indefinitely, because quipment was going to wear out in a very short time. Also, it was realized that the scarcity of materials and manpower would grow increasingly critical as the war progressed. Ways and means had to be provided to supply the service.

Carrier Well Developed

During the depression, when it was necessary to effect every possible economy, considerable pioneering work was done on remote metering (telemetering), automatic frequency control, automatic tie-line load control, high-speed relaying, carrier current communication and ultra-high-speed re-closing of oil circuit breakers as a means of conserving dollars. The years following the depression had provided time for engineers to improve the design of this equipment and improve the technique of application and operation. It immediately appeared that here was the answer to the problem. Apparatus that had all been tried out, improved and tried out again, until it became a full-fledged operating tool waiting to be used.

Telemetering Contributions

Carrier - current communication holds first place in importance in successful operation of co-ordinated systems because it furnishes the most rapid and unlimited means of communication between dispatching centers and generating stations, which is absolutely essential. Changes in the movement of large blocks of power over co-ordinated systems take place in a matter of split seconds, and if dispatching must wait for the completion of telephone calls over commercial systems, the emergency may have passed or become much more serious before the call is completed. The importance of rapid communication increases as the loads become greater in proportion to the capacity of the co-ordinated group.

Next in importance is telemetering. Rapid communication alone is not enough. There are lines that need to be supervised by dispatchers and plant operators simultaneously. If a

dispatcher must call a station to make a change in loading on a tie line, it may be too late to make the change or the change may be in the wrong direction by the time the call is completed. It is, therefore, essential that readings on lines far remote from a regulating station be brought to the operator at the regulating station. This is accomplished by telemetering schemes. Modern schemes permit readings on important lines and stations to be seen simultaneously at a number of points within the system and at remote points on adjoining systems. A great deal of the apparatus used in telemetering is common also to carrier communication, in that the channels are both provided by carrier frequencies capacitively coupled to the transmission conductors.

The mere fact that important readings have been telemetered to regulating stations may not be sufficient. It must be continually borne in mind that speed is of prime importance in interconnection operation. By the time an operator who has other duties to perform gets around to make an adjustment, the line may have tripped out or the system may have become unstable, so to obviate this likely condition the readings are put through automatic load control apparatus which automatically makes the adjustment at once. The functioning of this equipment can be biased to regulate in anticipation of trends and with speed which is equivalent to an operator making an adjustment every two seconds. It may be desirable to do the regulating in several stations, either simultaneously or proportionately. Here, again, carrier-current channels are used to transmit the correcting impulses to selected stations.

Relays Clear Faults

Troubles will occur which trip out these important lines; the heavier loaded the lines are the more severe the shock is to the system; obviously it is essential that only the line in trouble trips out, and does so rapidly. To accomplish this carrier-current relay systems are employed which operate to isolate a fault before the system can go into an unstable condition. The speed with which carrier-current relay systems operate demanded that oil circuit breaker operating time be speeded up. This led to the development of eight-cycle breakers. After a line had tripped out it usually meant serious overload on remaining lines, and inasmuch as most modern lines could be reclosed a large percentage of the time ultra-high-speed reclosing mechanisms and relays were developed which allow a breaker to be reclosed before various parts of the system lost synchronism.

The foregoing sets forth the need for various pieces of apparatus and the subsequent development and application. Now as to what has been accomplished by the application of this equipment and its effect on the war effort.

Carrier Releases Capacity

Utilization of maximum transmission line capacity was of great importance. A double-circuit line tying two areas together, representing some 6,000,000 kw. each, had a stability limit of some 140,000 kw., but due to regulating swings some 40,000 to 50,000 kw. of this capacity had to be reserved for the swings. Automatic regulating equipment had been applied to this tie before the war, and with additional equipment installed on the interconnecting systems and the proper co-ordination of the control equipment nearly all of the reserve capacity of these lines was released for carrying useful load. With the continual transfer of 40,000 to 50,000 kw. of regulating power, unnecessary line losses occurred, and these had to be made up from some generating source which deprived the system of much-needed generation. The proper automatic operation of these ties and others in the same system made it possible to maintain loop operation, with its greater capacity and diversity, forestalling the installation of additional 200,000 kw. of generating capacity until later in the war. This period was very important because at the start of the war programs for heavy armament had to be carried on which took the same manufacturing facilities that were needed to make turbo-generators. If any generating equipment could be done without or delayed, it meant that much more material and manufacturing facilities for armament.

To maintain maximum generation from the existing equipment meant that all plants of all vintages must be operated. Obviously, the older plants could not be expected to hold up under long hours of operation, so automatic control made it possible to maintain generation on the largest and newest plants, requiring only peaking service from the older plants of the system.

Automatic Control

Automatic tie-line control and telemetering plays an all-important part in the co-ordinated operation of the large hydro systems with adjoining steam systems. To take advantage of the tremendous peaking capacities of the nation's hydro systems, it is necessary to make maximum use of steam power at all times and to store water in the hydro reservoirs for peaking. With the increased load factors of the new loads, the "off-peak" periods of the steam systems are materially shortened and the "on-peak" period of both the steam and hydro systems are lengthened. Consequently, in order to make up the energy in the shortened period, lines must be loaded to capacity during every possible minute of the "off-peak" period. In one of the country's largest combinations of this kind several million kilowatt-hours per day of energy from steam are utilized to displace hydro-generated energy, thus making the latter available on peak, resulting in an increase in peaking capability of 50,000 to 100,000 kw. on hydro. This was made possible by the use of automatic tie-line control and telemetering.

Industrial generation connected in parallel with utility systems can sometimes affect the capacity of important ties. For example, a large steel mill with generating capacity was responsible for a system surge of considerable magnitude, caused by the operation of a strip mill; this was felt through systems covering some twelve or fourteen states and for several hundred miles. The utility company is now installing regulating equipment which will confine the swings to its own system and this will release nearly 20,000 kw. of transmission line capacity.

Fuel Saving Still Imperative

At the present time the fuel situation is as serious as any material problem has been since the start of the war. It is important now that we conserve every bit of fuel possible, be it coal, oil, gas or stored water. Load control must play a very important

part in this conservation by permitting generation on most efficient plants. When 10,000 kw. of load is carried for a day on a 1-lb.-per-kw.-hr. plant, when it could have been carried on 0.9-lb.-per-kw.-hr. plant it means that 12 tons of fuel have been wasted. The same is true with division between steam units and hydro units or coal and oil burning plants.

Smaller companies with some generating equipment, but interconnected with larger systems with more efficient plants, can, through transformer banks, make the most use of the transformer capacity and also the fuel saving by the application of automatic tie-line control.

It should be pointed out here that most of the automatic tie-line load control-telemetering-carrier communication and carrier-relay systems that I am talking about here were in operation before the war and were ready for use immediately. A comparatively small amount of equipment has been installed during the war, only that associated with the new installations of equipment and some on the older important ties being installed in the last year and a half.

When more capacity is needed executives will do well to have their organizations investigate the possibilities of releasing some otherwise bottled-up capacity by using automatic load control and new, high-speed relaying systems. And similar investigations should be made for fuel conservation.

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Hotpoint Issues Study of Post-War Retailing

More than 14,500 retailers have applied for monthly mailings of "Planned Electrical Merchandising" a study of retailing principles aimed at post-war conditions, since the bulletins were first announced in December, G. H. Smith, general sales manager, Edison General Electric Appliance Co., Inc., has announced.

"The study upon which the bulletins are based includes retailing fundamentals for all lines of business," Mr. Smith said . . . "The material deals with basic retailing procedures which must be followed by retailers, if they are successfully to meet highly specialized competition after the war," he stated.

Trace Fuse Blowing To Excitation Surge

D. C. transient of lightning surge magnetizes transformer core, producing magnetizing current sufficient to cause transformer fuse operation

M. C. WESTRATE and G. D. STEVENS†*

BLOWING of distribution transformer fuse links during lightning storms has for years been accepted as an unavoidable nuisance that must be tolerated even though, in most cases, no flashover or apparent damage to the transformer has resulted. Grounded neutral and isolated neutral systems, alike, seem to be subject to about the same kind and amount of trouble from this source. Moreover, fuses on several adjacent transformers are frequently blown simultaneously. Occasionally, branch sectionalizing fuses are similarly affected.

During 1942, for example, one company division with 8,353 transformer installations experienced 936 interruptions of which 758 were caused by transformer fuses blowing during lightning storms. Of this number, 694 were fuse operations without any apparent transformer damage.

Increase Minimum Size

To minimize these interruptions of service, some companies have increased the minimum size of fuse link used, in spite of appreciable loss of thermal protection or clearing ability on secondary faults. Increasing minimum fuse sizes has, no doubt, helped to reduce the number of these interruptions. It has not eliminated them and may perhaps have caused some increase in the number and seriousness of transformer failures.

In attempting to determine reasons for blowing of fuse links, an attempt has been made by the authors to reproduce actual service conditions in the laboratory and observe the action of fuse links subjected to electrical impulse currents. From these tests and observations it appears that the major factor contributing to the blowing of transformer fuses by lightning may be the magnetizing of the transformer core by the transient d.c. lightning surge, which in turn causes a high magnetizing current to flow, in succeeding cycles.

No Evidence of Cause

It is quite obvious that such surge currents could flow through primaries of grounded neutral transformers and it is also reasonable that a sufficient d.c. current could flow through primaries on isolated neutral transformers, whenever two phases are at a different surge potential either due to direct stroke, flashover, or arrester discharge on one phase only.

In arriving at a satisfactory explanation of the cause for blowing of distribution fuse links it will be recognized that a large number of fuse operations occurring during lightning storms leave no evidence of flashover or damage to equipment. What then, is the nature of the currents involved and what paths do they follow? Blowing of a branch sectionalizing fuse can be readily associated with a traveling wave flowing through the surge impedance of the line, but this would not seem to hold true for a transformer where the surge impedance is very high and the lightning arrester is connected on the line side of the fuse.

Several possible current paths through transformers may exist and will be considered in the following discussion.

Sufficient surge current might be

* Communication Equipment & Engineering Co., Chicago, Ill.; formerly associated with Commonwealth & Southern Corp., engineering department, Jackson, Mich.
† Consumers Power Co., Jackson, Mich.

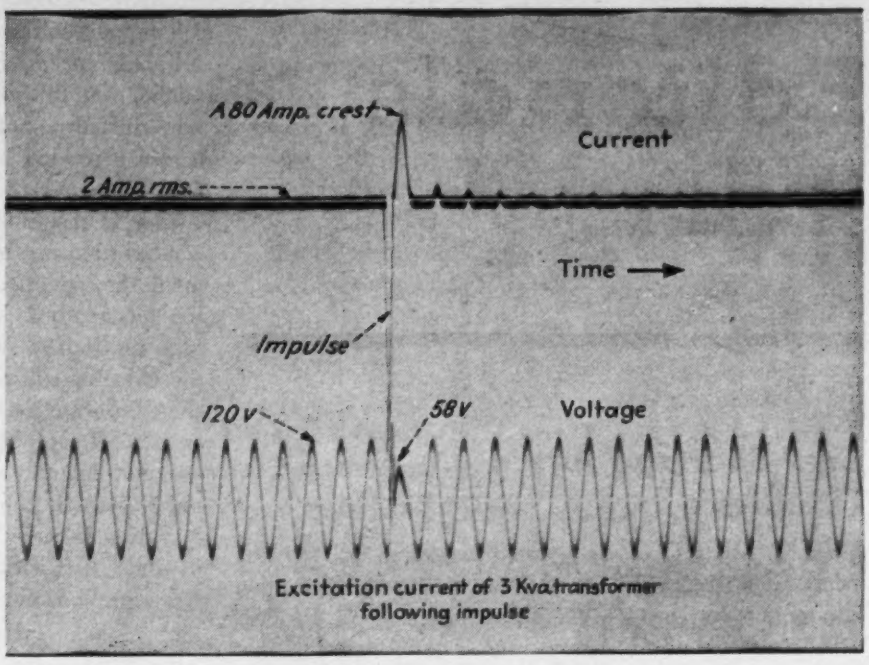
supposed to flow through the capacitance of the transformer, either primary to secondary or primary to tank and core, to blow the fuse. Observations by the authors, however, indicate that surge current through the capacitance of the transformer is negligible. This could not be measured without a cathode ray oscillograph; however, the conclusion is based on the fact that the discharge spark from the surge generator was small when impressed between the transformer and the secondary alone. A three-ampere fuse was the smallest size tried and it did not blow.

Another possible cause considered was flashover of the transformer, or puncture of the winding, without sufficient damage to prevent its withstanding normal operating voltage. This possibility did not lend itself to laboratory test and does not seem to be a reasonable explanation for all cases in view of the fact that flash-over and puncture of windings has been experienced with various makes of transformers regardless of age. Besides, fuse trouble has been experienced on isolated neutral as well as on grounded neutral systems. It is doubtful that line-to-ground power current on most isolated neutral systems would be sufficient to blow the fuses involved. A flashover or puncture would of course provide a path for lightning current but it does not seem logical in such case that several transformers should be involved adjacent to the one flashed over or punctured.

In spite of the high surge impedance of the transformer, some surge current does flow through the transformer winding, even though the voltage is limited by a lightning arrester and this current may contribute, in varying amounts, to the total current which flows through the fuse link and eventually results in blowing it. This observation is based on the small amount of discharge current evidenced in the external gap of the expulsion type arrester indicating that the bulk of the discharge must have passed through the transformer winding.

Polarized Magnetization

Another possible and in the author's opinion, most probable cause for the blowing of transformer fuse links may lie in the fact that lightning surges, being d.c. transients, may magnetize the transformer core sufficiently to cause a high magnetizing current to flow. This condition is illustrated on the accompanying oscillogram. Saturation of the transformer core by impulse current through the primary winding was found in this instance to produce excitation current in the secondary, during the succeeding half-cycle, which was seven times full load current or 170 times normal excitation current; even though the regulation of the 120-volt excitation circuit caused voltage to drop to 50 percent of normal.



OSCILLOGRAM shows that excitation current of 3 kva. transformer reaches value seven times full load current on half cycle succeeding application of "lightning" impulse

Suitable equipment was not available to make this test with excitation on the primary side. Therefore the rating of a fuse link that would withstand this excitation current could not be determined by test.

Tests by the authors also indicated that relatively large fuses may be blown readily by surge current alone even though the surges are very steep and of short duration. Branch sectionalizing fuses may, therefore, be blown by the lightning surge current or by the magnetizing current of a number of transformers following a surge on the circuit.

Solution to the problem of blowing of transformer fuses on lightning surges may lie either in obtaining fuse links which will handle the necessary magnetizing current, since no apparent damage is done, or it may be possible to devise some method of preventing the surge from flowing through the transformer winding. If an attempt is made to solve this problem by the use of fuses with greater current carrying ability, it would be desirable to have this increased short time current carrying ability arranged so as not to increase the rating of the fuse. To do otherwise would sacrifice all transformer thermal protection and most fault protection. This will probably require a new fuse design.

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Correction, Please

Referring to the article entitled "Chart for Determining Maximum Overload of a Transformer for a Definite Length of Time," in ELECTRICAL WORLD, March 18, 1944, page 116, two corrections in the copy as edited have been called to our attention, as follows:

Under the example, the transformer is operated at 40 percent load and the dotted line on the nomograph should have been extended from the 40 percent load line instead of from 50 percent load to the six hours on the time scale.

In the table, second column, fourth number from the bottom should have been 119.1 instead of 191.1 C.

Editorials

S. B. WILLIAMS, *Editor*

Coal Shortage Again Threatens

A COAL SHORTAGE is again threatening. All requirements for this year are something in excess of 600 million tons or an average of 12 million tons a week. Production, except for an occasional week, continues below that figure. Many reasons are given but they do not alter the fact that unless something is done to maintain coal output in excess of 12 million tons each week there is not going to be enough coal to go around.

This isn't the first time that a warning has been sounded on coal supply but each time the country has passed the crisis. Now, however, there isn't the same storage supply available and we must live more directly out of the mine than before.

Donald Nelson, WPB chairman, last week called on large users of coal to store as much coal now as they possibly can in order to maintain coal production at top level. From a peak supply of 113 days the first of June last year the electric utility storage has steadily diminished to 60 days at the first of March. To the extent that SFA will permit, this storage should be built back, not that it will necessarily provide any large amount of insurance, but because it might help to alleviate a difficult situation for all coal users later on in the year.

Co-operation at this time may help to postpone any solid fuel limitation order, but the fact must be faced that if production is not maintained rationing of some sort must follow. That brings up a question of how it will be done.

It should be obvious by this time that voluntary conservation cannot be relied on to effect the desired savings. The electric utilities have since last fall given of their manpower and money to make the voluntary program work and they have accomplished a lot, but there was too little evidence that the others in the voluntary program were carrying their weight.

The electric utilities, although they burn but 13 percent of the total coal production, and therefore can at the best make but a minor contribution to conservation, have demonstrated in every way their sincerity in doing voluntarily what they can to help. They should not be left to hold the bag alone.

Many power utility managements, although they gave full support to the coal conservation program, were never fully convinced of the need for such a program. It may be that even this year we may pull through without getting into difficulty, but the wise thing is not to wait until trouble develops, because this time the wolf may really be at the door.

This is the time to start working on a workable fuel conservation measure. Instead of waiting to be told how much the reduction will be, it would be far better to have the data ready to show what the savings will be if certain uses are limited. When a program of this nature is ready the industry will be in a better position to insist that the same information be supplied by other large coal consumers. If everybody participates to their ability the load will not fall too severely on any one industry and the public will be more conscious of the necessity. If conservation is really necessary let's do what we have to do in time. If it isn't necessary let's say so and not trot out any more hair cloth.

The New Boss of the Power Utilities

WHEN IT BECAME KNOWN that J. A. Krug was leaving the Office of War Utilities to take a commission in the Navy there was much speculation on his successor because it was known that other groups would like to have the war control of utilities. The industry was much relieved when Krug's deputy, Edward Falck, was named as his successor.

The new director has had a year or more in which to win the confidence and respect of the power utility industry. Almost from the very beginning of OWU a little over a year ago, he has had to carry most of the burden of its direction because Krug was loaded down with the program vice-chairmanship of WPB. In that time the new director has demonstrated his ability as an administrator.

Falck was also associated with Krug when the latter was head of the old power branch of WPB so that the new director is well grounded in the policy of OWU administration and, having taken such an active part in it himself, can be expected to maintain it rather than branch out for himself.

The Office of War Utilities has had the reputation of being one of the best administered war agencies in Washington. Much of this is due to the kind of men who came from industry to do the job. Regardless of the fact that the staff was made up of men from public and private power and from REA, these men worked together with no more friction and dissension than would be found in any normal office. It has been about as nice a bit of teamwork as one would ever experience. This is perhaps as fine a tribute as one could pay to the management of OWU.

While the new director has inherited Krug's office he

s not necessarily inherited Krug's freedom from inter-rence. The Office of War Utilities was born in an in-rnal governmental battle for jurisdiction and its new ader must be strong enough to hold the position won by s predecessor. Some of the opposition will come from thin WPB where there has been jealousy over OWU's gree of freedom from red tape and some will come om without. Nothing will make it easier for the op-sition to step in than evidence of lack of support of e industry.

Falck has a background in public power the same as rug, but he has an equally good private industry back-ound. This alone should erase any reservations that the dustry would be bound to have were the director to me from the camp of public power.

If the new director is to be successful against those o would place far greater restrictions on the utility dustry, he must have the vigorous support and unre-rved confidence of the industry which his background d administration as deputy so amply justify.

luorescent Impractical r Street Lighting

ANY PEOPLE have asked if fluorescent tubes are going be used for street lighting after the war. From a survey de by ELECTRICAL WORLD a year ago it is apparent that interest is great. No factual information was available, wever, until this month when results of researches made Nela Park were presented in *Illuminating Engineering*. hile it is technically possible to apply fluorescent tubes street lighting, and in some respects with improved ality of illumination, the researches disclosed that this plication of fluorescent lighting is not practicable at present time. In other words, it costs too much for light it gives.

It was furthermore disclosed that there is nothing pend-which gives any reason to believe that this situation l alter materially for some time. Research, of course, l continue, but until some economical way is found overcoming some of the inherent limitations of the e, the older light sources can be expected to continue serve this field.

However, because of its display effect there is the possi-ty that some decorative lighting may be used in the wntown store areas. Where advertising values out-gh economy, fluorescent lighting offers a much greater portunity for dramatic effects than the older white-way ting, as was demonstrated before the war at the New rk World's Fair. Pylons of light, brilliant colors and er spectacular effects can be arranged with fluorescent ting that can make business sections as attractive to ht shoppers as a flame is to a moth.

When it come to utilitarian lighting, on the other hand, inherently low lumen characteristics of tubes make ecessary to provide such bulky fixtures, and so much closer together in order to get enough light of good distribution, that it is very unattractive by day, besides being prohibitively expensive in first cost.

While those who have been looking to fluorescent as a means of reducing the operating costs of lighting streets because of the greater efficiency of the source are going to be disappointed, it is far better that its limitations should be known now so that false hopes may not hold back the already too long delayed rehabilitation of the nation's street lighting.

Basic Rules of Safety and Codes of Good Practice

IN A REPORT submitted at the beginning of the year, the post-war planning committee of the British Institute of Electrical Engineering draws attention to the need for basic rules of safety in its wiring regulations quite apart from any code of good practice. When the Ministry of Public Works in preparation for post-war building asked the representative English professional bodies to prepare Codes of Good Practice it became evident to the electrical engineers that such codes would be incomplete without a basic regulation of minimum safety.

In the United States we operate under the National Electrical Code which, although it purports to be a code of Minimum safety rules is in effect a code of practice. For some time ELECTRICAL WORLD has been urging what amounts to the same action for this country as is now recommended by the British Institute of Electrical Engineers for England.

If we can establish the basic rules of safety, which might be termed the safety units, then factors of safety can be determined which will constitute the regulations for minimum safety. These will be basic and nobody will be permitted to go below them.

However, in the interest of better operation of devices, greater convenience, and increase usage, it would be advisable to have a better job. What is a good job? What is good practice?

Isn't that what we need in this country? A truly minimum safety regulation that can be the basis for inspection both of new and old work and a code of good practice?

The standards for adequate wiring provide the quantities for a code of good practice and the National Electrical Code provides many of the qualities. Perhaps what we need is a reshuffling and regrouping, but all built around a basic set of rules for minimum safety. If this is done we may find that we have eliminated the difficulties for recognition of new methods and new materials and at the same time erased the freezing effect of the Code upon wiring practice. With the concept suggested the industry would have a ceiling in practice that would provide the good operator with all the latitude for salesmanship he might desire.

Washington Comment

By R. N. LARKIN, Washington Correspondent

Senate May O.K. Ickes Power Grab

DESPITE ITS DEFEAT in the House, the amendment to the Rivers and Harbors Bill giving Interior Secretary Harold L. Ickes control of all surplus energy generated at the eight power projects designated in the bill (ELECTRICAL WORLD, April 1, 1944, page 68) is far from dead.

Sen. Homer T. Bone, Washington Democrat and Senate public power leader since the defeat of ex-Sen. George W. Norris, plans to re-introduce the amendment. Chances for its passage by the Senate are considered distinctly better than they were in the House, and in conference, the House might accept the provision since, because of the immensity of the bill, which contains several hundred projects located all over the land, too many Congressmen stand to lose too much federal money for their own districts to run much risk of the measure's complete rejection.

Under the amendment, which may also be inserted in the Flood Control bill pending in the House, Ickes would be given control of all power not needed in operation of the projects and directed to market it, with preference to public bodies and cooperatives, on terms approved by the Federal Power Commission. Power facilities would be installed and operated by the Army engineers as directed by Ickes, who would be able to buy or erect such transmission lines and other facilities as he deemed necessary.

What the President Wants

The amendment originally was put into the bill by Chairman Joseph J. Mansfield of the Rivers and Harbors committee in line with a more or less general feeling that the President would veto the measure if it contained no over-all policy for distributing the power provided therein. Or, the reasoning ran, if the President failed to veto the bill, he would send along in short order a new measure providing such policy, as he did after Bonneville and Fort Peck dams had been approved without the type of power marketing set-up he and Ickes wanted.

The Interior Department's drumbeaters insist that the amendment is elementary, that without it, or something exactly like it, the power to be generated at the proposed dams would go to waste since there would be no legal policy for its disposal. This contention, like many other contentions of Ickes' followers, is somewhat less than accurate. There would indeed be no over-all statutory policy for the disposition of this power along the lines of the Bonneville Power Administration, with federal agencies specifically organized to establish and promote public power districts, cooperatives and municipal systems. There would, however, be an over-all statutory policy providing that the power be sold by the Army engineers at the bus bar under contracts approved by the Federal Power Commission. If the bill becomes law without the Ickes amendment, this is what will happen.

Like the Engineers Better

House members who know the situation say there is no widespread feeling in the lower body that Ickes is just the man who should have jurisdiction over the proposed generating capacity. They say it would generally be more acceptable to the House if the Army engineers were to market the power in large blocks at the bus bar where public and private agencies alike could compete for it, paying rates under which a floor presumably would be set in the public interest by FPC. That these members are not entirely incorrect in this feeling is evidenced by the House rejection of the Ickes plan, and approval of the Engineers' authority.

While the issue fails to approach in importance certain others on which Congress has beaten the Administration recently, it is a further indication of the House's reluctance to leave its prerogatives and its duties in the hands of the executive, who exercised both for so long. The Ickes amendment probably was specifically asked for by the Administration since it was not originally included in the bill. That the committee sponsored it—under the real or implied threat of a veto—despite the absence of its own unanimous approval is due to the fact that the committee leaders are administration men, expected to advance the administration program regardless.

"Irrigationist" Sentiment

Ickes' popularity in Congress naturally is greatest with western members. Since the sparsely populated western states have equal representation in the Senate with the east, the chances of the amendment's passage in the Senate must be considered brighter than they were in the House, where the west fails to muster equal voting strength with the east. By the same token, the "irrigationist" sentiment—strictly pro-Ickes—being stronger in the Senate than in the House, Ickes stands to gain greater support for his grab in the forthcoming debate.

The proposal of Rep. Everett M. Dirksen, Illinois Republican, for one central agency to run all but the regulatory part of the nation's power enterprises (ELECTRICAL WORLD, June 12, 1943, page 82) becomes more and more logical with each such skirmish as this over the Ickes amendment. Actually, however, the possibility of its enactment becomes more remote daily, for Congressmen today are thinking in terms of disestablishing some existing agencies rather than forming new ones. The recent power proposal of Sen. Bennett Champ Clark, Missouri Democrat, called for existing agencies to handle the new capacity, as did the Arkansas power bills introduced some time ago by Rep. Wilbur D. Mills and Sen. John L. McClellan, both Arkansas Democrats. The Ickes amendment rides the crest of this trend.

NEWS OF THE WEEK

Coal Situation Serious, Nelson Tells Consumers

WPB Chairman urges all possible stockpiling — Anticipated shortage 25,000,000 to 45,000,000 tons — Sees decreased production and increased requirements — Manpower loss a factor

Complicated by a steady and increasingly great loss of manpower, the nation's coal supply picture was at its darkest this week, pinched at once between prospects for decreased production and increased requirements.

In a letter to industrial consumers, WPB Chairman Donald M. Nelson urged all possible stockpiling because of an anticipated shortage of between 25,000,000 and 45,000,000 tons during the coal year started last April 1. Nelson said the coal situation is more serious than it has been during the past three years.

The Solid Fuels Administration for War has long predicted a 20,000,000-ton deficit in bituminous coal production for 1944, based on estimated requirements of 620,000,000 tons and estimated production of 600,000,000 tons. As long as miners brought 12,500,000 tons above ground weekly under the settlement negotiated last fall by Solid Fuels Administrator Harold L. Ickes and United Mine Workers Boss John L. Lewis, the picture looked bright. Since that time, drafting of fathers and cancellation of occupational deferments for men under 26 have cut output for several weeks to 12,000,000 tons or less, and threaten to cut it further as the young men go to war.

That the estimate of requirements for 1944 totaling 620,000,000 tons may have been low is inescapable from the revised figures of 1943 consumption. Bituminous consumption last year is now set at approximately 610,000,000 tons. SFA's estimate for 1944 boosts this by 10,000,000 tons only. Electricity output for 1944 is estimated at 7 percent above 1943. If this increase be applied on a nationwide basis, the electric industry will use 7 percent more coal than the 76,000,000 tons it consumed in 1943, or a total of approximately 81,250,000 tons. Thus one industry would use more than half of the 10,000,000-ton increase SFA allowed for 1944 in its preliminary estimates.

Britain's coal strike has not helped the U. S. supply situation at all, it has become known on excellent authority. The United Kingdom had contracted to furnish a sizable amount of coal for use in liberated areas and other off-shore points. The recent strike and several other factors have combined to reduce the amount the United Kingdom can export to fill these "must" needs by 75 percent. Thus, if these commitments are filled, they will be met with U. S. coal.

HOW WILL THAT NEW UNIT SUB LOOK?—To help utility and industrial engineers plan and lay out unit substations with greater ease and realism Allis-Chalmers Mfg. Co. is supplying its field engineers with scale models of unit substation components like those being studied above by (l. to r.): W. C. Johnson, Allis-Chalmers vice-president and general manager; R. S. Fleshiem, manager, electrical department and Fred W. Bush, assistant to the manager, electrical department. Models are scaled ½ in. to one foot and made of wood. Kits will include 35 equipment models also single-line diagrams of possible substation arrangements, layout sheets scaled to the same dimensions as models and a "check list" providing other necessary engineering data

It is not anticipated that measures to meet the threatened increase in the 1944 bituminous coal deficit by curtailing use will be rushed into effect immediately since the nation is now entering the period during which it produces more coal than it uses and the supply situation is thus not immediately desperate. The immediate emphasis is expected to be laid on fullest possible production and controlled stockpiling wherever possible.

With the national stockpile at dangerously low levels, however, rigid cutbacks by industrial and domestic users will have to be invoked later this year if the deficit mounts beyound the anticipated 20,000,000 tons. C. J. Potter, Deputy Administrator of SFA, has made passing mention of the necessity of cuts by the Army and Navy as well, but is certain that domestic users will take a cut before the services. One observer pointed out that a reduction in the quarterly allocation of steel, currently running around 15,000,000 tons per quarter, would not only save directly twice as much coal as the amount of steel cut off, but would also save additional coal which would be expended in the fabrication of that steel and the transportation of the finished products it made.

Certainly, if the coal becomes as tight as it appears it will become, the use of electric energy for outdoor advertising and other "luxury uses" would be halted, along with elimination of luxury uses in other industries.

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Predicts Tacoma Will Use Steam Plant by Fall

The whole Northwest power pool faces a shortage of hydro-electric power and Tacoma will be operating its steam plant by fall to furnish electricity for home and industrial use, according to Verne Kent, City Light engineer. There is little snow in the mountains, Mr. Kent said, and Tacoma is 13.15 inches short of normal rainfall, or about 40 percent.

Present indications point to July 15 as the probable date when Nisqually power will be available, but there will not be any water behind the dam this year so the plant will only develop the stream flow, which will be low in the summer and fall months.

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Eire Curbs Electricity

A dispatch from Dublin states that the government of Eire has directed that effective May 1 electricity may be used for lighting only.

Wartime Electrical Work Featured at Boston

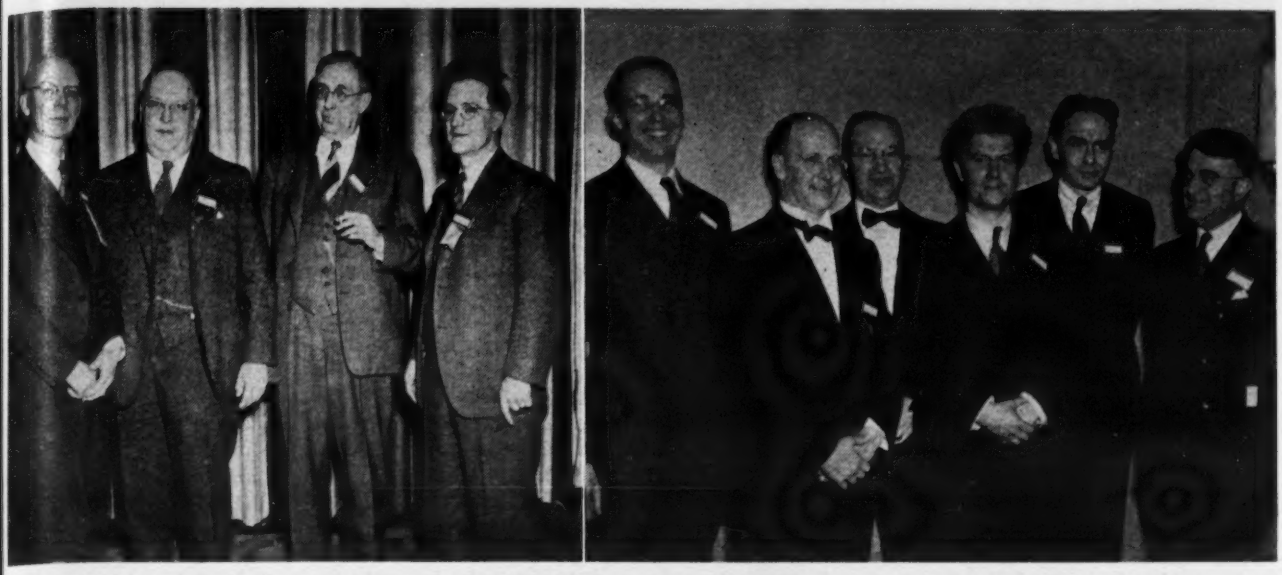
A.I.E.E. proceedings emphasize advances in apparatus, material design, and operation accelerated by emergency— Institute's Sixtieth Anniversary observed

Six hundred thirty engineers gathered at Boston, Mass., on April 19–20 at a record-breaking Northeastern District Technical Meeting of the A.I.E.E. to discuss trends in equipment and material development, and widen their understanding of electronic applications, machinery, transmission, synthetics, cables, welding, and industrial power control and regulation. While the usual side trips and plant inspections were omitted because of the war, the opening day was highlighted by a pleasurable observance of A.I.E.E.'s sixtieth anniversary, past-president D. C. Jackson being master of ceremonies. President N. E. Funk concisely outlined the Institute's history from its organization in 1884 to the present membership of over 20,000, with 74 local sections, 125 student branches, 55 committees, and far-flung relationships with government, education and industry. Dr. Funk forecasted outstanding opportunities for future electrical development, as did D. C. Prince (chairman G.E. post-war committee).

R. D. Speas (American Airlines) sketched advances in aviation and cited the need of more reliable, flexible and economical electrical auxiliaries, including facilities for maintaining constant generator speed in the face of varying engine r.p.m., eliminating glare in cockpits, and design of more ornamental lighting for cabins. W. B. Carnie (Montaup) described a system transmission changeover from 66 kv. delta to 110 kv. Y without interrupting customer service or having construction personnel accidents. Eight major steps were involved, with network analyses, equipment conversions and additions, detailed drawings of all field changes and complete sequence moves.

C. A. Streifus (Ebasco), C. S. Roadhouse (Nebraska Power), and R. B. Gow (formerly Kansas Gas) compared

DISCUSS EQUIPMENT TRENDS—Material development and equipment trends were examined at the A.I.E.E. technical meeting. Left to right (seated): Irving E. Moultrop, consultant, Boston, Mass., and former chief engineer, Boston Edison Co.; Dr. D. C. Jackson, past president A.I.E.E., director emeritus, department of electrical engineering, M.I.T.; Dr. D. C. Prince, past president A.I.E.E., vice-president, General Electric Co., Schenectady. Standing: Prof. C. L. Dawes, Harvard Graduate School of Engineering; Frank Thornton, Jr., Westinghouse, East Pittsburgh; J. G. Patterson, past chairman Boston section A.I.E.E., New England Telephone & Telegraph Co.



ANNIVERSARY CELEBRATED—At the Northeastern District Meeting of the A.I.E.E. in Boston last week, the opening session was highlighted by the observance of the Institute's sixtieth anniversary. Among those attending the meeting were (l. to r.): Thomas Cooper, Jr., chairman Boston section, and general chairman, District Convention, New England Telephone & Telegraph Co.; Dr. Nevin E. Funk, president A.I.E.E., Philadelphia Electric Co.; Sidney Withington, New Haven Railroad; Dr. K. B. McEachron, vice-president A.I.E.E., General Electric Co., Pittsfield, Mass.; S. B. Farnham, General Electric, Schenectady; R. G. Warner, United Illuminating Co., New Haven, Conn.; R. T. Henry, incoming vice-president A.I.E.E., Buffalo, Niagara & Eastern Power Co., Buffalo; J. R. Pattee, Bristol Co., Waterbury, Conn.; A. G. Conrad, Yale University, New Haven; T. J. Russell, past chairman, Connecticut section A.I.E.E., Westinghouse Electric & Mfg. Co., Bridgeport, Conn.

test values and computations of fundamental electrical constants of a 270-mile, 154-kv. transmission line, including basic line impedance and admittance units. Computed values appeared reasonably satisfactory for positive sequence units of resistance, reactance and susceptance, and zero phase sequence impedances.

Cable Session Fertile

W. D. Fenn and L. A. Gray (Simplex Wire) described a new portable (automobile mounted) compact high-voltage d.c. equipment for field tests of insulation quality or fault locations. The authors stated that high-voltage d.c. tests give indications of abnormal leakage at much lower potentials than is normally expected. Developmental work is now under way on a new type of Murray loop test to follow the d.c. voltage test, but this is not ready for field use.

C. A. Finkel (Okonite) reviewed the current status of synthetic insulations for cables. Beside the well-known synthetics now adapted to wire and cable are many other compounds, including those made with Butyl rubber, which show promise but are still in the experimental stage. Koroseal and Vinylite insulations are limited to about 600-volt a.c. service (except for series street lighting up to 5 kv.). GR-S (Government Rubber-S) has won a far-reaching use in the synthetic conversion program. The indications are that within a few months the conversion to Buna S or other synthetics will be complete. High-grade natural rubber insulating tapes are still available. Natural rubber will probably be a strong competitor of synthetics after the war.

The Insulated Power Cable Engineers Association Committee on Research (R. J. Wiseman, chairman) presented an exhaustive study of the current rating of cables as affected by mutual heating in air or conduit. The research was conducted by the Electrical Testing Laboratories under the supervision of an I.P.C.E.A. committee. Variations in the watts per conduit foot for the same conductor temperature rise were investigated for conduit groupings includings 1-in. and 4-in. ducts, and also for a single conduit. Correction factors for various groupings were developed.

G. B. Shanklin (G.E.) presented a paper emphasizing the soundness of gas-filled cable design based on five years' service. Some 20 installations ranging from 15 to 120-kv. have been made in this country. Gas pressure control is excellent. Special strengthening of the inner zone of insulation in the high stress field near the conductor has not been found necessary.

A vibration detector for rotating machinery was described by R. L. Webb and C. S. Murray (Consolidated Edison, New York) with excellent operating experience, and J. G. Noest of this company read a paper on the prevention of rotor winding deformation in turbogenerators by a preheating program. Practical procedures have been found easily co-ordinated with turbine starting operations.

W. M. Leeds (Westinghouse) presented a paper on smaller tank oil circuit breakers, discussing a new line of high-speed units from 115 to 230 kv., having about half the previous weight and oil volume.

L. G. Tubbs (Westinghouse Co.) described the development of air-cooled induction regulators to avoid the hazards of oil fires and explosions. The rotor diameter is somewhat larger than with liquid cooling. Special attention is given to the air circulation design, with insulation basically of mica, glass and asbestos to withstand temperatures up to 125 deg. C. H. Winograd (Allis-Chalmers) presented details of an excitron type rectifier in which a cathode spot is maintained continuously on the surface of the mercury anode, when in operation, by a pilot arc, with grid-controlled firing. P. T. Chin and E. E. Moyer (G.E.) contributed a paper on the graphical analysis of voltage and current wave forms of controlled rectifier circuits.

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Detroit Edison Meeting Scheduled for May 15

Detroit Edison Co. has called a special meeting of stockholders for May 15 to vote on changing the certificate of incorporation in order to permit an in-

crease in the maximum number of directors from nine to eleven. If the proposal is adopted it is intended that the number shall be fixed, for the present, at ten.

It is expected that at the meeting Prentiss M. Brown, former head of OPA, will be elected director and chairman and that James W. Parker, at present a director, vice-president and general manager, will be elected president (ELECTRICAL WORLD, April 1, page 74).

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Indiana Utility Employees Strike

One hundred linemen, electricians and trouble shooters of the Northern Indiana Public Service Co. walked out, on strike, last week in a jurisdictional dispute between the International Brotherhood of Electrical Workers (AFL) and United Mine Workers, district 50. Striking employees, members of Local B-9, International Brotherhood of Electrical Workers, walked out Saturday (April 22) in protest against the discharge by the company of ten men.

Discharges were required of the utility company by the United Mine Workers, Local No. 12775, which won a union shop in a NLRB election last October. The new contract signed at that time contained a maintenance of membership clause. The ten discharged men, officials of the AFL affiliate, sued to enjoin the company from checking off $1.50 a month from their wages as dues to the UMW. They lost the suit and appealed. Their discharge was demanded of the company under the UMW contract signed last October.

Dean H. Mitchell, of Hammond, president of the company, said he would stick to the union shop contract. He pointed out that the company had been under contract to the IBEW from 1935 until the NLRB election changed the bargaining agent. IBEW had a union shop contract with the company from 1938 until last October.

The 100 striking linemen, Dean Mitchell stated, are scattered over the company service area comprising Hammond, East Chicago, Gary, South Bend, Michigan City and Valparaiso. There are 900 men in the bargaining unit.

First effects of the walkout, which is not a general strike, was felt when 60 families had their electric service impaired by lightning storms Sunday night. Some delay was experienced in restoring service, due to the strike, but by Tuesday morning service to all interrupted customers was restored.

Sees Big Post-War Market for Electric Industry

A. A. Brown urges Oklahoma utilities to have faith in industry's possibilities and to make plans now—Post-war unemployment and flood control discussed

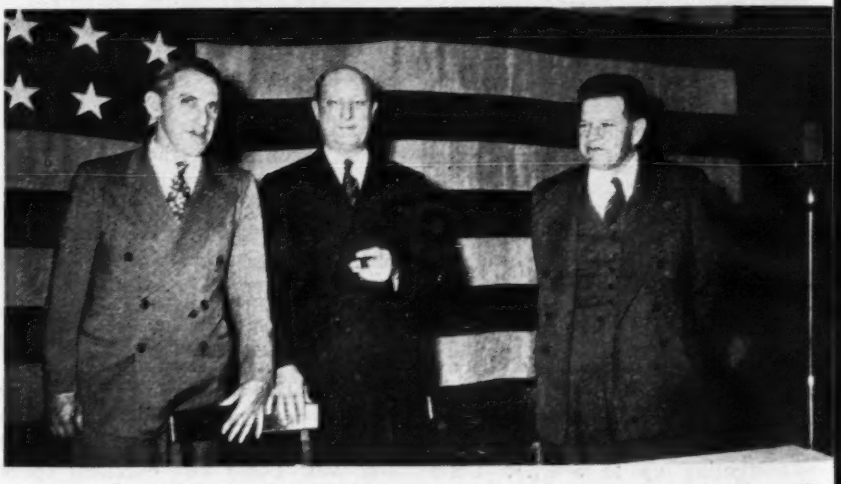
If America after the war has progressive political leadership which will not discourage free enterprise, a great potential market awaits the electric light and power and appliance and equipment industries, declared A. A. Brown, vice-president, Oklahoma Gas & Electric Co., in an address before the one-day convention of the Oklahoma Utilities Association held recently in Oklahoma City. Much also depends on leaders in the electrical industry, who must have faith in the possibilities of the forward planning and enterprise of the situation and act upon it, Mr. Brown said.

J. C. Happenny, president, Oklahoma Power & Water Co., Sand Springs, Okla., warned against the rapid advances of bureaucracy and consequent departures from the fundamental principles upon which our nation was founded. "The whole 175 years of our existence have demonstrated the strength of individual ownership and free enterprise as the main principle of our prosperity," said Mr. Happenny. The Rural Electrification Administration has departed far from its original purpose, that of bringing electricity to the farm, and through relief from taxes and other subsidies, is seeking to compete directly with the electric light and power industry within the field where the latter now has its investments and is giving complete and satisfactory service, Mr. Happenny charged.

A definite program to meet post-war employment problems should be worked out now by the electric light and power and other industries, J. A. Whitlow, vice-president, Public Service Co. of Oklahoma, Tulsa, advised.

So-called flood control and power dams do not prevent floods, Elmer T. Peterson, associate editor of the "Daily Oklahoman" told the delegates. Reservoirs, already full to increase the production of power, do not leave any room for flood waters, and overflows, in the valleys below such dams, are only rendered more destructive. He cited the $127,000,000 worth of damage in the lower Arkansas River Valley in May, 1943, below the Grand River Dam, as an example.

"While advocates of public power are seeking 100 million dollars in additional appropriations to spend on building more great power dams, and so-called flood control projects, some of the existing dams have been used to produce more electricity instead of to control floods," Mr. Peterson said. "Besides the enormous flood damage in Oklahoma and Arkansas, I estimate that fully 25 feet of silt, mostly from rich



ASSOCIATION OFFICERS—The camera-man lined up this group of Association officers at the recent meeting of the Oklahoma Utilities Association in Oklahoma City (l. to r.) D. S. Kennedy, Oklahoma City, treasurer; A. F. Potter, Bartlesville, second vice-president and E. C. Joullian, Oklahoma City, Association president

Kansas and Oklahoma farms was deposited behind the Grand River Dam during the great 1943 flood in the Neosho and Grand Rivers. Instead of spending vast sums in building dams which, according to estimates of experts, will fill with silt and be rendered absolutely useless within from 25 years to 50 years we should build trillions of little dams . . . to hold back the floods at their source and to keep the top soil in place," Mr. Peterson said,

S. I. McElhoes, Public Service Co. of Oklahoma, was elected chairman of the electric light division. The board of directors elected George A. Davis, president, Oklahoma Gas & Electric Co., first vice-president of the association to succeed George McLean, deceased. About 200 delegates attended the one-day convention.

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Amends Regulation on Coal Purchases

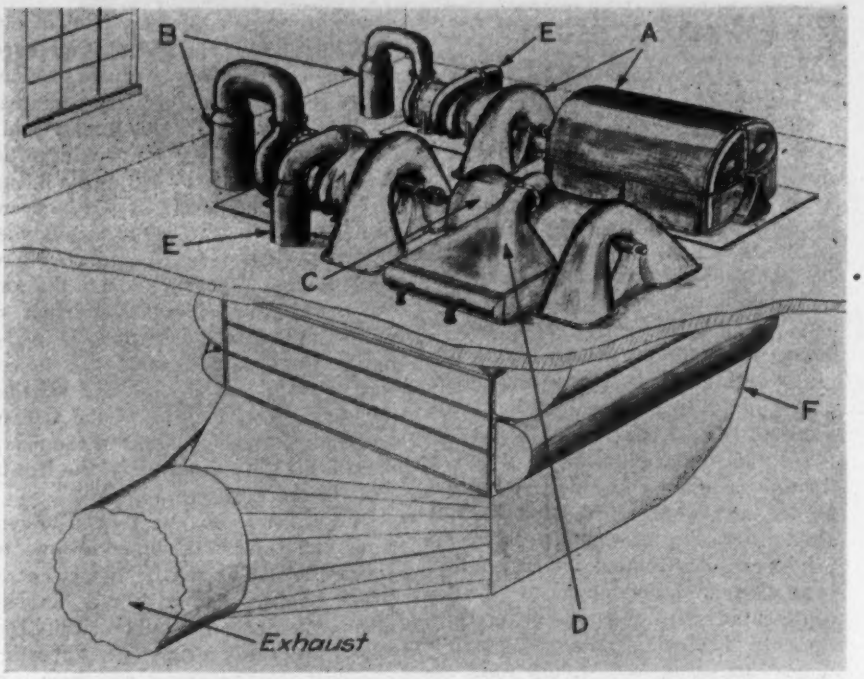
Solid Fuels Administration for War has amended its Regulation 10, governing coal stockpiles and purchases, to allow utilities to purchase their monthly burn in any district except 7 or 8 and to allow stockpiling out of any districts where free coal may be found.

Under the latest version, purchases in districts 7 or 8 are governed entirely by the amended stock limitation table in Regulation 10. The difference between what coal may be purchased in 7 or 8 and the monthly burn may be purchased without restriction in any other district. The amendment does not curtail the right of those utilities whose stocks are so low that they may, under the limitation table, purchase their monthly burn or more in districts 7 or 8 to do so, however.

Utilities which have more than 30 days' supply may stockpile coal only if they can find free coal in any district or by purchasing in districts 9, 10 and 11 up to 120 days' supply.

Regulation 10's limitation table has been amended both with respect to utilities and other industrial users, with the latter curtailed more stringently than utilities. Net effect of the changes are to allow those who have low stocks to build them more slowly than heretofore permitted and to force those with greater stocks to draw down somewhat faster than previously.

Utility holders of up to 25 days' supply, both on rail or tidewater shipping routes, were cut 10 percent in the amount of excess over monthly burn which may be purchased in districts 7 or 8. Utilities receiving coal by rail whose stocks are 26 to 35 days were cut 5 percent and those having 51 to 55 days' supply, also 5 percent. Utilities receiving coal by tidewater holding 36 to 40 days' or 56 to 69 days' supply were also cut 5 percent.



AN ARTIST'S CONCEPTION—The accompanying illustration shows a 5,000-kw. open cycle gas turbine plant, as a Westinghouse artist conceives it, using reheat, intercool and regeneration. Two gas turbines are used: one a constant speed generator drive, the second a variable speed compressor drive. (A) constant speed gas turbine and generator; (B) combustors; (C) variable speed gas turbine and compressor; (D) intercooler; (E) reheater, combustor; (F) regenerator

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CMP Regulation 9-A Broadened by WPB

WPB has broadened CMP Regulation 9-A, under which repairmen of all kinds are allowed to obtain materials for their work, to include the purchase of materials with which to recondition or rebuild damaged or used items for resale, but at the same time has warned that repair services are being greatly handicapped by the failure of many repairmen to avail themselves of opportunities afforded by the regulation.

The amendment broadens the term "repairmen" to include those who repair or recondition equipment for resale and allows them to buy material for such purpose, provided the material is not used to replace useable parts or to improve the design of the article being rebuilt.

Repairmen are not allowed to apply CMP 9-A's automatic AA-3 rating to the purchase of capacitors, resistors, transformers, tubes or several other items, all of which are made available to them without rating.

WPB urged all repairmen to operate under CMP 9-A since it is designed to aid them to keep in operation electrical appliances and other civilian items which are not now being manufactured. It provides automatic ratings for controlled material and established quotas which may be purchased with little formality for repair uses. A survey of repair shops on a nation-wide basis indicates that many repairmen are unfamiliar with the plan. Copies of the regulation may be had at any WPB field office or from the Electrical and Mechanical Repair Section, Service Trades Division, Office of Civilian Requirements, WPB, Washington 25, D. C.

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Bill Approves 14,000 kw. Station in Michigan

Rep. Fred Bradley, Michigan Republican, has introduced a bill authorizing construction of a 14,000-kw. hydro station on the St. Marys River at the foot of St. Marys Falls, in Michigan, and subsequent abandonment of the existing Army-owned plant at Sault Sainte Marie, now under lease to the Edison Soo Co.

Bradley's bill limits construction strictly to the first step of the plan for the St. Marys River as recommended by the Chief of Engineers. Cost of the first step is estimated at $3,500,000. Power would be sold by the Secretary of War.

Post-War Lighting for Hospitals

Formative stages in the development of post-war lighting for municipal institutions were disclosed in the shop of the McPhilben Manufacturing Co., New York, recently to a group of suppliers, architects, engineers and city officials. The company was commissioned by the Department of Public Works of the City of New York to erect in its factory a testing room for proposed lighting fixtures for future hospitals and other public buildings included in the post-war construction program of the city.

On this occasion several different lighting ideas for hospitals were exhibited and were discussed and criticized from every standpoint—intensity, brightness, distribution, color quality, heat dissipation, maintenance—by the representatives of the various interests present. The exhibits were set up in a room simulating a hospital ward in full scale complete with bed representations, so that lighting conditions affecting comfort of patients and their care and examination by doctors and nurses could be determined by test and experience. Although the exhibit was intended only for the purpose of bringing out suggestions for improvement in and over the fixture designs offered, there appeared a consensus that fluorescent indirect lighting including a considerable use of plastics for enclosures and grids would dominate the post-war field of hospital lighting in New York.

Raver to Quit Role in Seattle Deal

Forecasting an end to attempts for the present by public agencies to purchase the Puget Sound Power & Light Co., Dr. Paul J. Raver, Bonneville Power Administrator, has asked to be relieved of his duty as the city's negotiator in the proposed $90,000,000 deal.

The request for release will be reviewed by the City Council's utilities committee. Dr. Raver stated in a letter to the council that "in view of the position taken by the company, it is apparent that they are now not willing to negotiate for the sale of their property on any reasonable basis. . . ."

Pursuant to a resolution by company directors, Frank McLaughlin, president of Puget Sound Power & Light Co., had notified the Bonneville administration of the company's inability to accept the offer of $90,000,000 for the electric properties of the company, terming the offer "grossly inadequate." Mr. McLaughlin promised, however, that any "fair purchase proposal" in accordance with the company's announced position, would receive the earnest consideration of the directors. His letter also said: "We further feel that we should go on record in this letter by stating we recognize that the taxpayers have a huge investment in the Grand Coulee-Bonneville projects. These projects have made a notable contribution to the war effort. . . . A proper coordination of public and private operations is in the public interest, and we desire to cooperate with you so that the existing and future potentialities of the Columbia River may be realized for the maximum benefit of the people of the Northwest in the post-war period."

The utility company's refusal to consider the offer was branded by Dr. Raver as "deliberately non-co-operative." Subsequent to these developments, Skagit County Public Utility District No. 1 after originally supporting the proposed program, withdrew. In a paid advertisement in a daily paper the PUD announced that the district is not in favor of "federal control of the entire power business of the Northwestern states."

Weiler Appointed Falck's Assistant

Charles F. Weiler, formerly chief statistician for the Wisconsin Telephone Co., Milwaukee, has been named assistant to Director Edward Falck of the Office of War Utilities.

Weiler's previous job as Chief of OWU's materials control branch will be taken by Harry Lowe, formerly with Sloan and Cook, Chicago consulting engineers.

Weiler, a graduate of the University of Wisconsin in 1929, spent his entire career with the Wisconsin Telephone Co. until he joined the old power division of WPB in June, 1942. He came to WPB at the request of former OWU director J. A. Krug to do a special job studying the effects of the Production Requirements Plan, then the WPB materials control device, on utility operations. Thereafter he undertook numerous special assignments until March, 1943, when he was made chief of the materials control branch.

Ben Loeb, who was deputy chief of the materials control branch under Weiler, will continue in this position.

MEETINGS

Pennsylvania Electric Association—Transmission and distribution committee, Penn-Harris Hotel, Harrisburg, Pa., May 4-5. M. M. Devorris, chairman, Pennsylvania Edison Co., Altoona, Pa.

Previously Listed

Edison Electric Institute — Technical committee meetings, Edgewater Beach Hotel, Chicago, Ill., May 1-4; annual meeting, Waldorf-Astoria Hotel, New York, N. Y., June 6-7. Col. H. S. Bennion, managing director, 420 Lexington Ave., New York 17, N. Y.

Association of Iron and Steel Engineers—Spring conference, Wm. Penn Hotel, Pittsburgh, Pa., May 8. Brent Wiley, managing director, Empire Bldg., Pittsburgh, Pa.

National Fire Protection Association — Annual meeting, Benjamin Franklin Hotel, Philadelphia, Pa., May 8-11. R. S. Moulton, technical secretary, 60 Batterymarch St., Boston 10, Mass.

Pacific Coast Electrical Association—Annual meeting, northern section, Fairmont Hotel, San Francisco, Calif., May 10; southern section, Ambassador Hotel, Los Angeles, Calif., May 17. Victor W. Hartley, managing director, 601 W. Fifth St., Los Angeles, Calif.

Southeastern Electric Exchange—Annual conference, Atlanta Biltmore Hotel, Atlanta, Ga., May 10-11. John W. Talley, executive secretary, 303 Haas-Howell Bldg., Atlanta 3, Ga.

Pennsylvania Electric Association—Systems operation committee, Benjamin Franklin Hotel, Philadelphia, Pa., May 11-12; E. W. Middleton, chairman, Pennsylvania Power & Light Co., Hazleton, Pa. Electrical equipment committee, Brunswick Hotel, Lancaster, Pa., May 11-12: A. N. Shealy, chairman, Pennsylvania Water & Power Co., Lexington Bldg., Baltimore, Md.

Arkansas Utilities Association—Annual convention Marion Hotel, Little Rock, Ark., May 15-16. R. E. Ritchie, secretary, P.O. Box 551, Little Rock, Ark.

Council of Electric Operating Companies—Contributors' meeting, Edgewater Beach Hotel, Chicago, Ill. May 18. T. P. Walker, president, 13th and F Sts., N.W., Washington 5, D. C.

Wisconsin Utilities Association—Conference of all sections, Pfister Hotel, Milwaukee, Wisc. May 19. A. F. Herwig, executive secretary, 135 W. Wells St., Milwaukee, Wisc.

Illuminating Engineering Society—Great Lakes regional meeting, Cincinnati, Ohio, May 20. G. R. Baumgartner, regional vice-president, General Electric Co., Nela Park, Cleveland 12, Ohio.

Public Utilities Advertising Association — Annual meeting, Palmer House, Chicago, Ill., June 6-8. Waldo M. Wright, secretary, Amarillo Gas Co., Amarillo, Texas.

National District Heating Association — Annual meeting, William Penn Hotel, Pittsburgh, Pa., June 14-15. John F. Collins, Jr., secretary-treasurer, 827 N. Euclid Ave., Pittsburgh, Pa.

Iowa Utilities Association—Post-war planning conference, Des Moines, Iowa, June 19-20. Wm. R. Blake, secretary-manager, 606 Fleming Bldg., Des Moines, Iowa.

American Society of Agricultural Engineers—Annual meeting, Schroeder Hotel, Milwaukee, Wis., June 19-21. Raymond Olney, secretary, St. Joseph, Mich.

American Society of Mechanical Engineers—Semi-annual meeting, William Penn Hotel, Pittsburgh, Pa., June 19-22. Ernest Hartford, executive assistant secretary, 29 W. 39th St., New York 18, N. Y.

Canadian Electrical Association—Annual meeting Murray Bay, Que., Canada, June 22-23. B. C. Fairchild, managing director, 804 Tramways Bldg., Montreal, Que.

Society for Promotion of Engineering Education—Annual meeting, University of Cincinnati, Cincinnati, Ohio, June 25-28. F. L. Bishop, secretary, University of Pittsburgh, Pittsburgh, Pa.

American Society for Testing Materials—Annual meeting, Waldorf-Astoria Hotel, New York, N. Y., June 26-30. Robert J. Painter, assistant secretary, 260 S. Broad St., Philadelphia 2, Pa.

American Institute of Electrical Engineers—National technical meeting, Jefferson Hotel, St. Louis, Mo., June 26-30. H. H. Henline, national secretary, 33 W. 39th St., New York 18, N. Y.

Energy Output Makes Recovery

Reversing the trend of the past few weeks, the output curve moved upward for the week ended April 22, 1944, according to figures released by the Edison Electric Institute. The amount of electrical energy distributed by the light and power industry during the week came to a total of 4,344,188,000 kw.-hr., as compared to the figure of 4,307,498,000 kw.-hr. for the week previous, which ended on April 15. Figures for the week represented an increase of 10.7 percent over the 3,925,175,000 kw.-hr. distributed during the corresponding week a year ago. The output for the similar week two years ago was lower, the total being 3,273,190,000 kw.-hr.

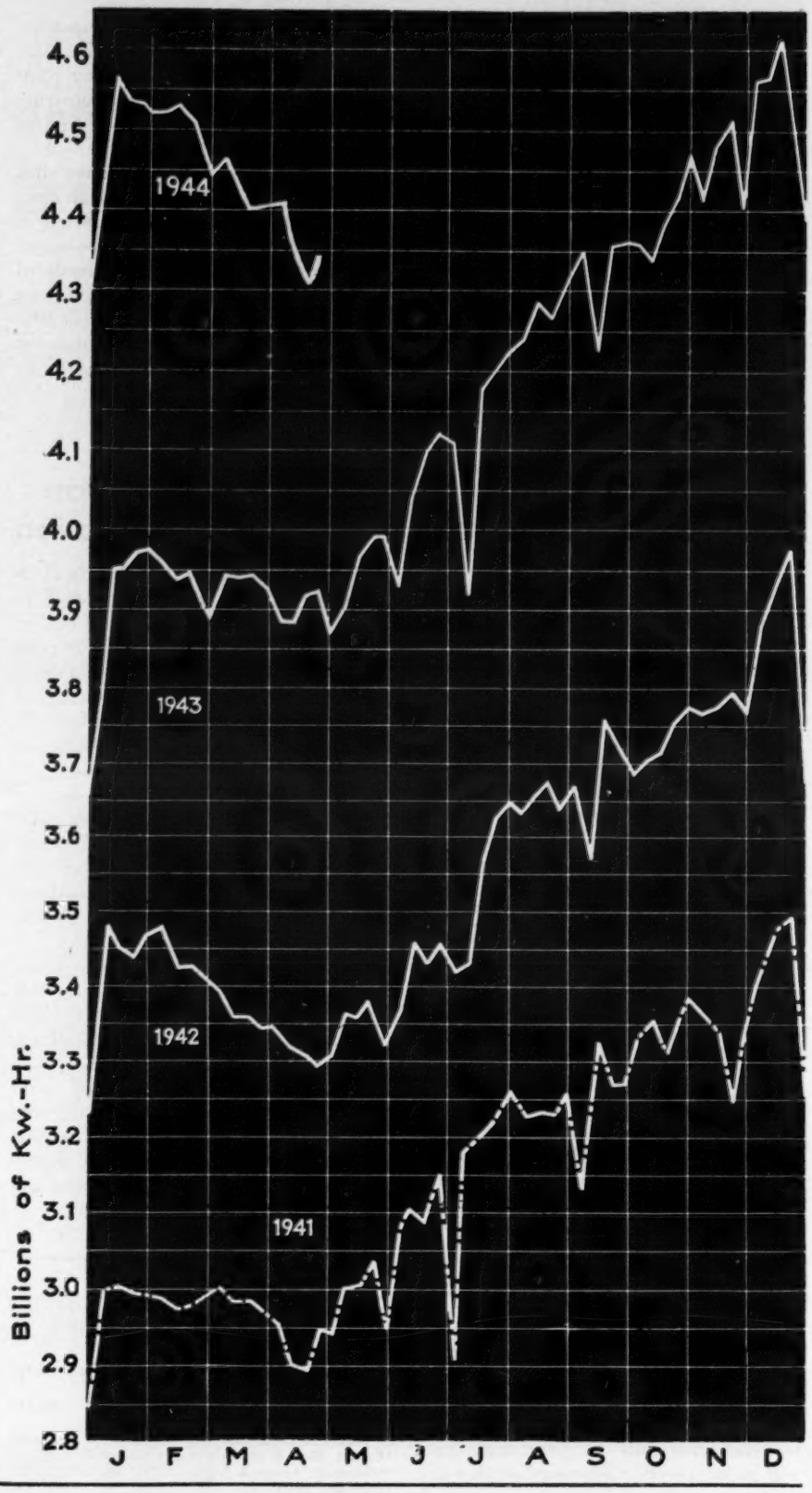
All of the seven major geographic regions of the country reported increases for the week over the corresponding week of the preceding year, the Pacific Coast region continuing to hold first place with an individual gain of 27.0 percent. The Southern States ran second with an increase of 10.3 percent, while the Central Industrial group, with a gain of 8.0 percent, held on to third place, which it had wrested from the Mid-Atlantic states the preceding week. The latter group reported an increase of 7.9 percent for the week ended April 22.

Weekly Output, Millions Kw.-Hr.

1944		1943		1942	
Apr. 22	4,344	Apr. 24	3,925	Apr. 25	3,273
Apr. 15	4,307	Apr. 17	3,917	Apr. 18	3,308
Apr. 8	4,361	Apr. 10	3,882	Apr. 11	3,321
Apr. 1	4,409	Apr. 3	3,890	Apr. 4	3,349
Mar. 25	4,409	Mar. 27	3,928	Mar. 28	3,346
Mar. 18	4,400	Mar. 20	3,947	Mar. 21	3,357
Mar. 11	4,426	Mar. 13	3,945	Mar. 14	3,357
Mar. 4	4,465	Mar. 6	3,947	Mar. 7	3,392
Feb. 26	4,444	Feb. 27	3,392	Feb. 28	3,409
Feb. 19	4,511	Feb. 20	3,948	Feb. 21	3,423
Feb. 12	4,532	Feb. 13	3,939	Feb. 14	3,421
Feb. 5	4,523	Feb. 6	3,960	Feb. 7	3,475

Percent Change from Previous Year

	Week Ending		
	Apr. 22	Apr. 15	Apr. 8
New England	+ 3.3	+ 3.3	+ 4.0
Mid-Atlantic	+ 7.9	+ 6.1	+ 9.1
Central Industrial	+ 8.0	+ 7.2	+ 9.0
West Central	+ 6.0	+ 2.8	+ 5.4
Southern States	+10.3	+10.7	+13.2
Rocky Mountain	+ 5.1	+ 5.7	+ 6.5
Pacific Coast	+27.0	+26.9	+30.2
Total United States	+10.7	+10.0	+12.3



Utility Revenues Increase 9.2 Percent in February

Electric operating revenues of the larger privately owned electric utilities in the United States in February, 1944, were $262,688,000, as compared to $240,488,000 in February, 1943, an increase of 9.2 percent, according to a report issued by the Federal Power Commission.

Revenues from sales to ultimate consumers were up 8.6 percent to $237,600,000 and electric operating revenue deductions (including operating expenses, depreciation and taxes) were $204,081,000, or 12.4 percent over those of February, 1943.

Revenues by classes of service in February, 1944, compared with the same month of 1943, were as follows: Industrial, an increase of 13.2 percent; residential, an increase of 6.3 percent; and commercial, an increase of 5.5 percent. Operating expenses in February, 1944, were $114,127,000 or 18.2 percent greater than in February.

Utilities Activate Post-War Planning

Program discussed at meeting of Northwest Electric Light and Power group

Engineers working in American industry have had more to do with waging war successfully than any other group outside our fighting men, Paul B. McKee, president, Pacific Power & Light Co., told a conference of engineers and operating men in Portland recently. The occasion was the annual conference of the engineering and operation section of the Northwest Electric Light and Power Association, with Harry M. Jones, Idaho Power Co., chairman.

Mr. McKee's remarks were made at the session on post-war planning, and he told of the recent meeting in Atlantic City of representatives of labor, industry, agriculture and other interests, where agreement had been reached on fundamental principles under which these groups could co-operate to build a better America after the war. "I am optimistic about the future," he said, cautioning his hearers that we still have a war to win. "We will need to extend help to other countries who need our technique, our money, our energy and our enterprise."

Patrick Johnson, vice-president, Puget Sound Power & Light Co., outlined the manner in which the association is organizing its post-war planning under the newly-formed Electrical Development Committee, of which he is chairman. It is difficult to differentiate between planning for war and planning for post-war, he stated, so it is our intention to plan "from here on out."

Some of the conclusions reached in the round table discussions of post-war planning were: release of pent-up purchasing power, shifting populations, changes in working habits and new loads and devices will mean a shifting of load and a change in peak characteristics which must be anticipated as far as possible by surveys; obsolescence will be taken care of by a more general replacement of equipment rather than repairing the old, to take advantage of improvements in the art; quality of service standards will be kept high and will be improved; customers' service departments will probably be expanded to take care of service on new devices that may not be adequately handled by existing service organizations; accident prevention activity in the future as in the past will be carried on through continuous promotion of safe working rules through personal attention by foremen and supervisors.

Renewed interest in farm electrification was evidenced now that construction restrictions have been modified. The extension policies of some of the companies are under review, as are construction specifications, with the view to possibly reducing line costs.

In a discussion of the manpower situation, it was revealed that a greater degree of stabilization had been noted in recent months, though the stiffening of selective service to meet the needs of the armed forces in the immediate future is expected to cause some difficulty. Companies operating on replacement schedules had found this system to be advantageous.

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Will Appeal PSC Ban on Consolidation

The management of the Niagara Hudson Power Corp. intends to appeal to the state courts the recent refusal of the New York State Public Service Commission to permit the Niagara system subsidiaries to consolidate into a single operating unit, Earle J. Machold, president, informed stockholders at their recent annual meeting.

Last January the Public Service Commission handed down a comprehensive decision rejecting the Niagara Hudson plan for consolidation and recently denied a petition of the company for a rehearing (ELECTRICAL WORLD, April 8, page 20).

"An appeal probably will be taken late in May to the New York Supreme Court," Mr. Machold declared. The two chief bases for appeal, he added, are that the commission "exceeded its authority in demanding extensive property write-offs to bring book values to a basis of original cost and in requiring application of straight-line depreciation of properties, retroactively applied."

Utility Reports

	Net Income 1944	1943
*American Gas & Electric and subs	$11,638,822	$11,071,754
*Central Arizona Lt. & Pwr.	884,139	835,589
†Detroit Edison and subs	9,036,790	8,235,350
*Kansas Gas & Electric	1,366,868	1,492,683
*Minnesota Power & Light	1,933,435	1,693,926
*Montana Power and subs	4,071,153	3,484,304
*Mountain States Power	747,087	673,691
*Nebraska Power	1,627,094	1,688,727
*Northern Indiana Public Service	573,903	690,428
*Northwestern Electric	644,885	684,665
*Pacific Power & Light	1,179,892	985,224
*Puget Sound Power & Light and subs	4,868,571	3,090,861
†Southern California Edison	9,369,011	9,792,831

* Twelve months ended February 29.
† Twelve months ended March 31.

British Industrial Users Cut 10%

The recent British Government order cutting industrial users of electricity by 10 percent and of gas by 25 percent because of the shortage of coal resulting from extended walkouts would be handled in this country under Order L-94 if a similar situation arose.

Necessity for the drastic action taken early this month by the British Ministry of Fuel and Power arose from the fact that Britain has no fat to pare off its power consumption schedule in absorbing a decrease in coal output. Having operated for almost five years under a blackout and under other power conservation measures, the British have had no need for an L-94 directing the order in which less essential users shall be deprived of service in an emergency.

In a similar situation in this country, an L-94 curtailment would prescribe the use of electricity for refrigeration for air conditioning, heating of transit cars, interior or exterior sign, show-window, show-case, ornaments, outline, decorative, advertising, night sports, white way and excessive commercial lighting. If further curtailment were necessary, it would be made on stipulated industrial users on a prescribed scale.

In addition to cutting industrial users, the British were forced to cut off-peak transportation service in northwest England by 20 percent. Factories were directed to do their own rationing. Failure to cut down by the stipulated amount would cause service to be turned off between prescribed hours daily, it was announced.

•

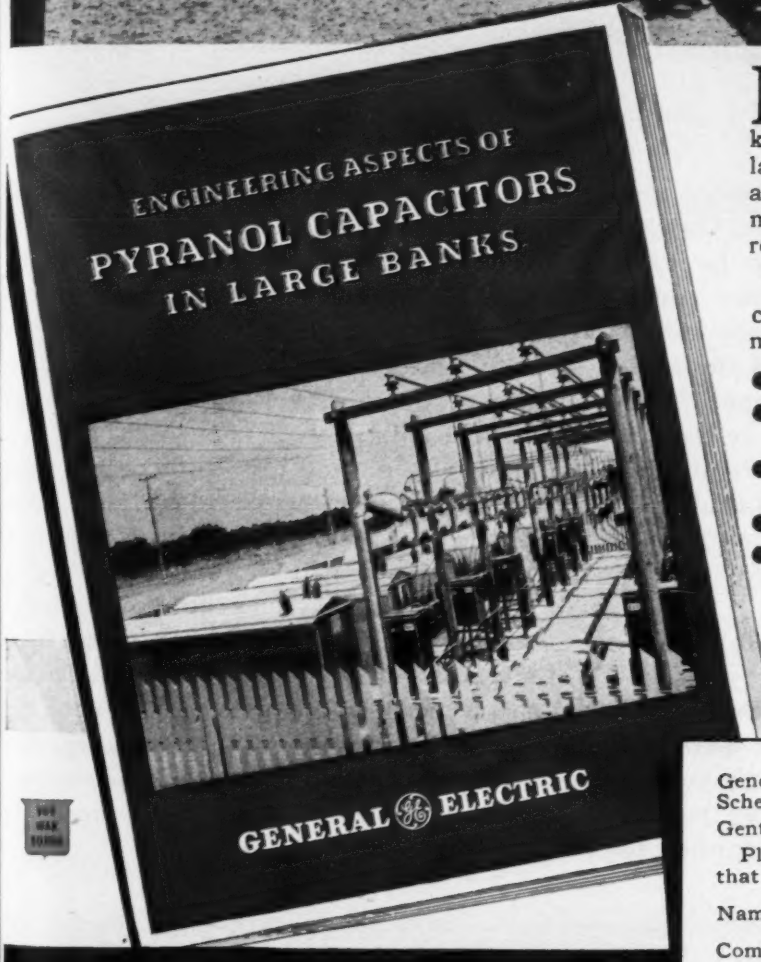
Refrigerator Men Report Labor Shortage to WPB

Production of repair and maintenance parts for electric refrigerators, including a.c. motors, is substantially above levels of a year ago, refrigerator service managers told WPB at a recent conference.

Greatest difficulty today is to obtain sufficient manpower to fabricate the adequate material WPB makes available for these parts, the managers reported, and the maintenance of skilled repairmen is becoming increasingly difficult.

About 85 percent of all a.c. motor production is going to combat equipment, but enough are expected to be available for essential replacements. Freon also is available for hermetically-sealed units in domestic refrigerators despite the rigid control over bulk uses of this gas.

How to apply capacitors in large banks *to* SUPPLY KILOVARS and RELEASE SYSTEM CAPACITY



IN the past two years a quarter of a million kva of Pyranol* capacitors has been installed in large banks *near the load*. One power company after another has taken advantage of this simple, material-saving way to supply reactive kva and release system capacity for war loads.

This new booklet contains answers to practically everything you might want to know about making such capacitor installations:

- Reasons for locating kilovar sources near the load
- Economies that can be effected by the use of capacitors
- Relative merits of synchronous condensers and capacitors
- Types of capacitor equipment available
- Application requirements and problems (How to mount, connect, fuse, switch, control, protect from lightning, etc.)

*Reg. U. S. Pat. Off.

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and get started right

General Electric Company, Section A407-74
Schenectady 5, N. Y.

Gentlemen:

Please send me a copy of your booklet (GEA-4225) that tells how to apply Pyranol capacitors in large banks.

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Company.....

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City..... State.....

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GENERAL ELECTRIC

"7 YEARS' CONTINUOUS OPERATION, ...NO FILTERING, MAINTENANCE NEGLIGIBLE"

...REPORTS A NEW ENGLAND COMPANY ON ITS EXPERIENCE WITH A 10,000-KVA, 66-KV PYRANOL POWER TRANSFORMER

SEVEN years ago the engineers of this New England utility needed a 10,000-kva, 66,000-volt transformer to be used between a water-wheel generator and a high-voltage bus. They wanted to install the transformer *indoors* to avoid the high cost of long runs of heavy copper. They also wanted to avoid concrete cells with specially designed drainage facilities. Hence a noninflammable transformer was needed—one that would not require a fireproof vault and yet would provide the greatest degree of safety.

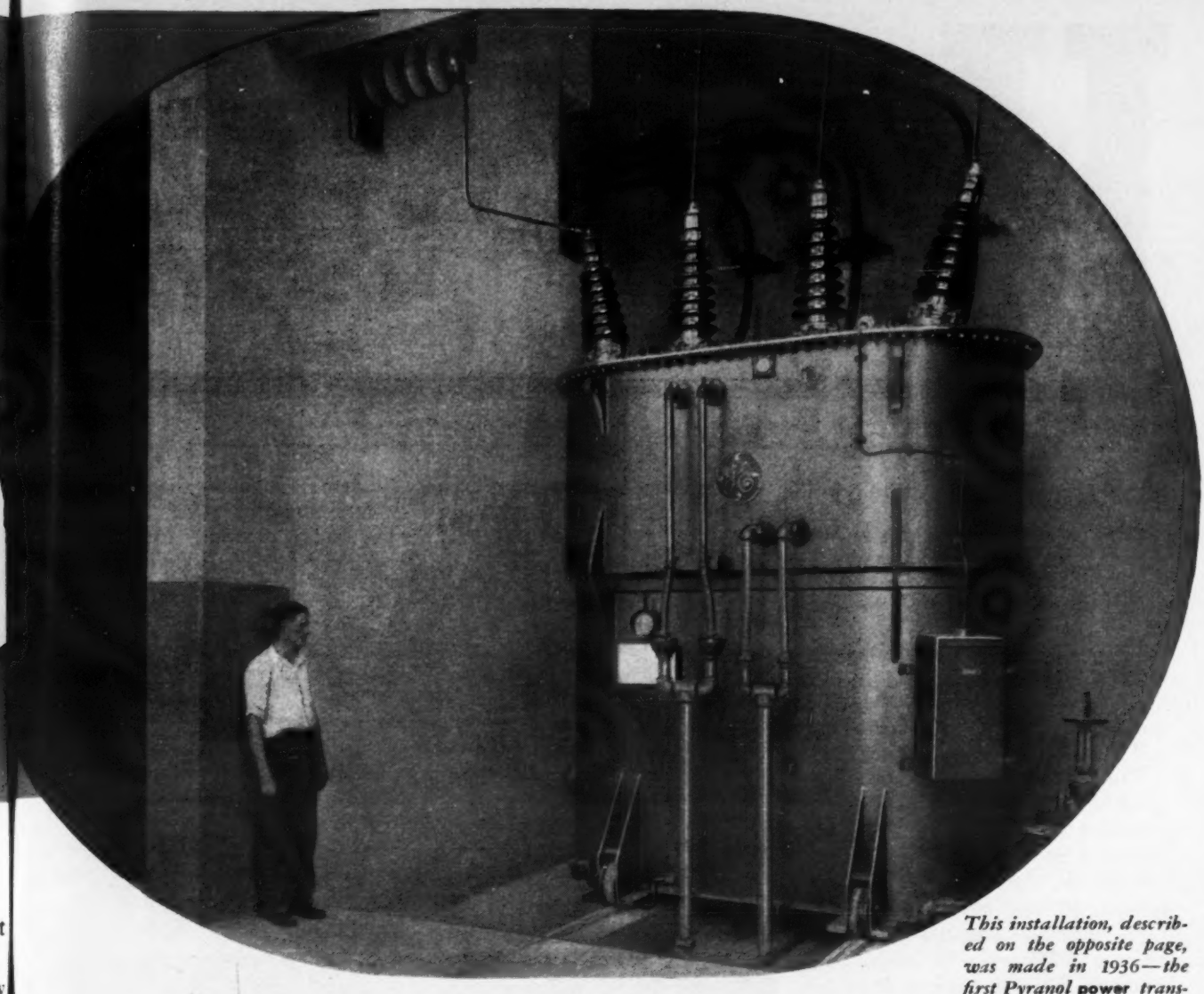
Pyranol* transformers, although introduced, commercially, only four years before this, had already proved themselves for indoor applications. Never had one burned or contributed to a fire. Operating records were uniformly excellent. But, for the most part, these had been applied to handle relatively small amounts of power at low or moderate voltage.

These engineers reasoned, and rightly so, why shouldn't a noninflammable Pyranol transformer be the economical choice for this large-capacity, high-voltage application? So a Pyranol power transformer was selected.

The wisdom of this choice has been amply demonstrated over the past seven years. The transformer has been in almost continuous operation, carrying varying loads up to its maximum rating. Samples of the Pyranol liquid have been taken from the transformer every year, and in each case analysis has proved that the Pyranol has maintained its original high quality. The time and expense of filtering have been avoided; there has been little need for maintenance of any kind.

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds.

*Reg. U. S. Pat. Off.



This installation, described on the opposite page, was made in 1936—the first Pyranol **power** *transformer application.*

THE benefits of Pyranol transformers, which have made them famous for distribution applications indoors, are just as real for *power-transformer* applications. For example:

- You can install them anywhere you wish, indoors or outdoors.
- Their inherent safety means that fireproof vaults or other fire protection is not required. Construction materials and installation time can often be saved.
- Pyranol is a stable liquid. It is nonoxidizing and nonsludging, and has high dielectric strength. Filtering is seldom, if ever, required.

It will pay you to consider the advantages of Pyranol for your transformer installations—large as well as small—wherever the elimination of fire hazard is an important factor. Ask for Bulletin GEA-4193. *General Electric Company, Schenectady 5, N. Y.*

PYRANOL POWER TRANSFORMERS

. . . available for circuits up to 69,000 volts

GENERAL ELECTRIC

401-17-5185, 5186

HOW DESIGN... CONSTRUCT OPERATE MAINTAIN

The How and Why of Welded Turbine Rotors

BY HANS DAHLSTRAND
Consulting Engineer, Steam Turbine Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Fabrication of turbine spindles by welding forged-steel disks and drums together, circumferentially, to form a solid rotor structure is a recent forward step in turbine manufacture.

The largest turbine spindle fabricated in this fashion to date went into operation on a middle-western utility system in December, 1943. Weighing 100,000 lb., the welded low-pressure spindle of this 147,000-kw., 1,800 r.p.m. machine, (throttle steam conditions; 1,250 psi., 925 deg.) was made up of six forged-steel disks and two forged-steel stub ends joined by welds near the outer peripheries. Each disk is grooved to carry blades.

For such large steam turbine units this fabrication technique brings multiple advantages over the convential method of shrinking spindle rings on a solid shaft or bolting parts together:

(1) With the rotor made from several small forgings there is greater assurance that no dangerous flaws exist in the forgings since thorough inspection may be made with ease.

(2) Smaller masses of steel respond more readily to heat treatment and therefore a better and more uniform material of greater strength may be obtained from the same type of steel.

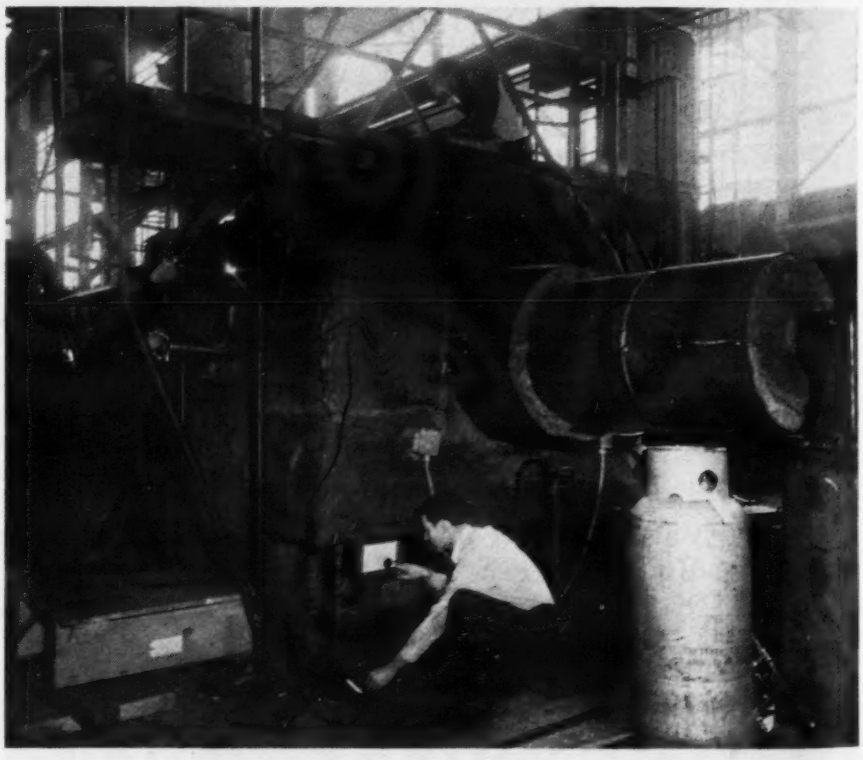
(3) The design may be modified to lower the stresses and thereby allow the use of a type of steel that is more readily available and easier to produce and heat treat, since it has more desirable physical characteristics.

(4) Reduction in weight to be carried by bearings without loss of strength or reliability.

(5) Elimination, in disks, of large bores that result in high tangential stresses.

This construction can be used in practically all turbine designs. In small units or in some special cases, however, it is more practical to use conventional designs. The limitation is largely one of cost. Small rotors would be too expensive to make up in parts and weld together. There would be no advantage in obtaining a better material as the size of the forging is already reduced so there is no difficulty in obtaining the class of material required.

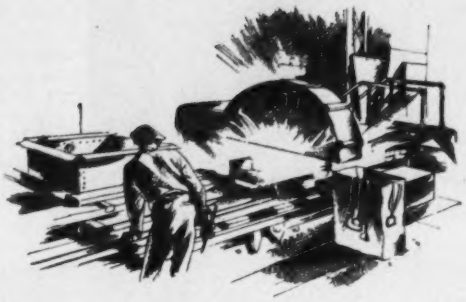
Because welding of as large a spindle as the 110,000-lb. rotor mentioned was unprecedented, special steps were taken both before and after welding. Sample welds of the same material as the forgings were made up and put through physical tests and X-ray examination. Sample rings with full size welds were made to study the behavior of welds and check the amount of peening required in the weld to prevent excessive distortion. All this was done *before* the spindle was welded. The material in the weld was, if anything, stronger

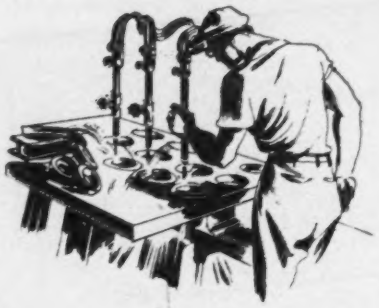


WITHIN an insulated housing, spindle is kept at 500 deg. F. constantly and turned at two revolutions per hour during both welding periods. In all 40 kw., of infra-red and resistance heaters maintained temperature

Can Ryerson Steel-Service Help You?

Steel Cut to Close Tolerance. Experienced crews working with modern high-speed friction saws, giant shears, powerful hack saws and other metal-working machinery can turn out steel quickly—cut, formed or otherwise prepared to your requirements. Steel that is cut to exact size and specification eliminates scrap and frees your man-hours for more production.





Any Shape Expertly Flame Cut. Skilled operators and modern equipment—combined with ever-present stocks of all types of steel—assure quick, accurate flame cutting and prompt delivery. Almost any shape, no matter how intricate, can be fashioned from steel plates or shapes. You save the time and expense of forging or casting and gain the added strength of rolled steel. Complete welded and riveted assemblies are also fabricated by Ryerson.

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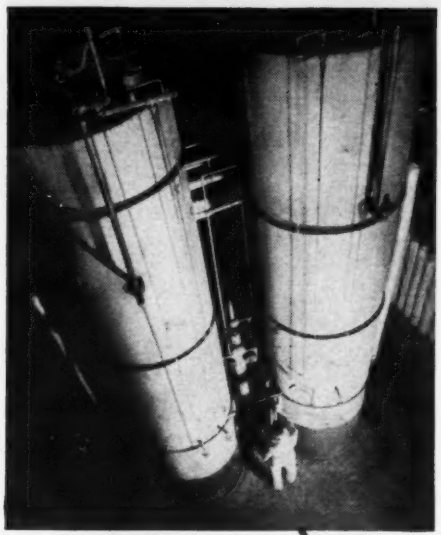
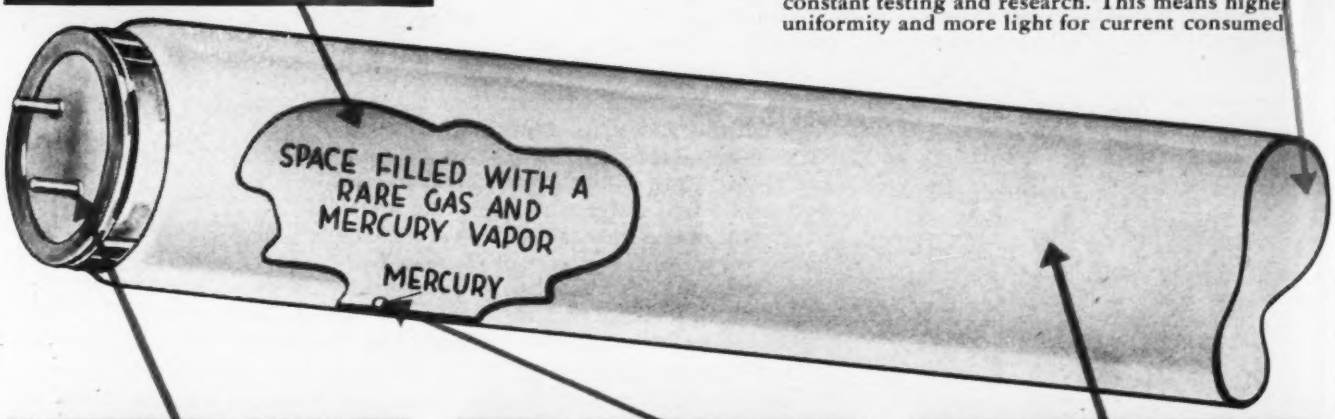
RYERSON

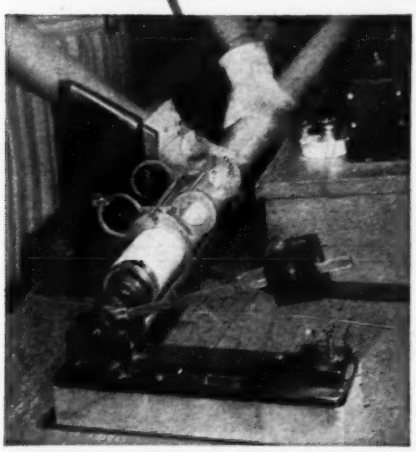
Here's the INSIDE STORY of



1 304° below zero sounds pretty cold. Freezing argon gas at this temperature means drier, purer gas making starting easier, more uniform.

2 Improved phosphor powders used in coating the inside of G-E fluorescent lamps result from constant testing and research. This means higher uniformity and more light for current consumed.





5 The "Twist Test" checks G-E lamp ruggedness to withstand twists, strains, bumps. This test applies pressure to the base, pins and tubes.

6 A tiny drop of mercury is accurately measured and injected by automatic machines to give G-E lamps better, lower-cost performance.

7 More than 480 tests and inspections guard the high quality of G-E Fluorescent lamps. Here G-E lamps are checked during the "seasoning" process.

Hear the General Electric radio programs: "The G-E All-Girl Orchestra," Sunday 10 p.m., EWT, NBC; "The World Today" news, every weekday, 6:45 p.m., EWT, CBS.

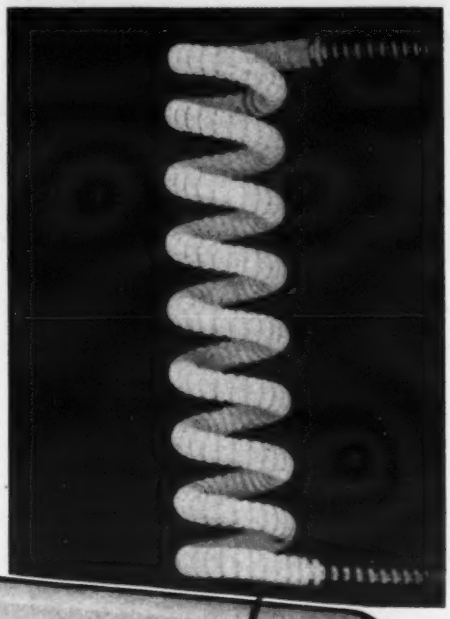
GENERAL ELECTRIC

a G-E FLUORESCENT LAMP

Chances are that you'll never examine what's inside a fluorescent lamp. But G-E engineers have done it—hundreds of thousands of times—in a constant, never-ending search for better and better lamp performance. Here are a few facts they've found out, while seeking more efficient, better lighting quality for fluorescent lamp users.

3 This instrument, the world's largest spectroscope, sets exact color standards for G-E lamps and provides assurance of correct color quality.

4 This coated cathode—here magnified many times—shows the sound, rugged construction which is built into every part of G-E fluorescent lamps.

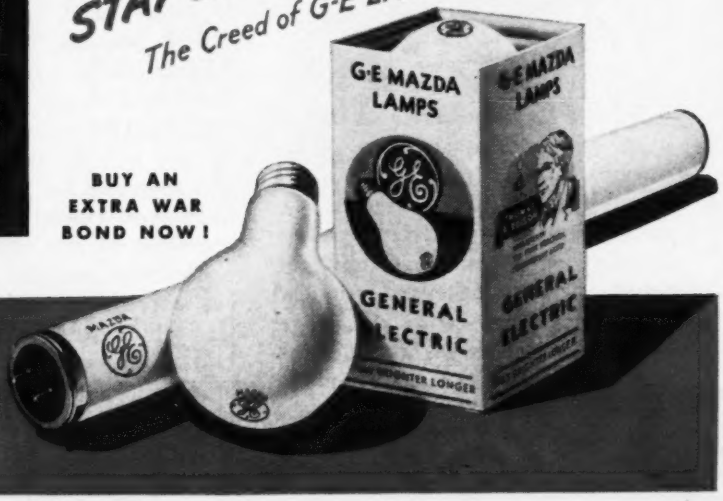


8 This is a barehanful of inside facts about G-E fluorescent lamps—the better lamps that give more and more light at lower cost than ever before. For all the FACTS write for this FREE booklet, Y-432. General Electric, Dept. EW-4, Nela Park, Cleveland 12, Ohio.

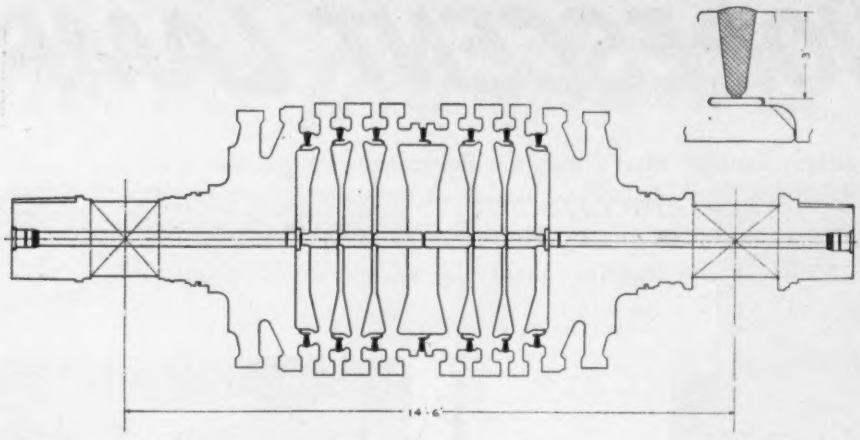
"TO MAKE LAMPS STAY BRIGHTER LONGER"

The Creed of G-E LAMP RESEARCH

BUY AN EXTRA WAR BOND NOW!



G-E MAZDA LAMPS



LOW PRESSURE spindle for 147,000 kw., 1,800 r.p.m. turbine made up of six forged disks and two stub ends welded together near outer periphery. Insert in upper right corner shows enlarged section of weld

than the parent material composing the disks.

During welding it was necessary to erect an insulating housing to encase completely the parts. Infra-red and resistance heaters totaling 40 kw. were installed inside the housing to maintain the temperature of the spindle at 500 deg. F. during the welding period. A hand and motor turning rig was devised so that the spindle could be rotated at a rate of two revolutions per hour while welding was under way and during the subsequent process of stress relieving in the furnace at 1,050 deg. F.

In the welding operations it was important that all the parts be as near as possible concentric, so that the completed spindle would require a minimum of balancing. By exercising care no trouble was encountered in keeping all parts centered. Consequently, balancing was just as easy as with any other type of spindle. The completed spindle of the 147,000-kw. machine, weighing 120,000 lb. with blading installed, required about 3 lbs. on a 30-in. radius to balance.

Spindle Assembly

Spindle forgings were heat treated, stress relieved and machined before assembly. Also, spindle disks and ends were statically balanced. The spindle was made up of two sub-assemblies. Each sub-assembly consisted of three disks and one end, stacked together vertically with tiebars tack-welded across adjacent disks at six points around the circumference. Welds in each sub-assembly were built up 60 percent complete and rotated at the 500 deg. temperature inside the housing until placed in the stress relieving furnace.

The two sub-assemblies were subsequently stacked vertically and 12 tiebars tack welded across the center joint. With the spindle raised to 500 deg. the center joint was welded 60 percent complete and the end joints 100 percent complete. After stress relieving, the partially finished center joint was radiographed. The weld was then completed and the entire spindle given a final stress relieving treatment.

•

Pressure Compensated Insulated Cable

By C. E. PLASS* and R. M. PEIRCE†
American Steel & Wire Co., Cleveland, Ohio.

Development of a pressure compensated cable employs the conventional type H-3 conductor paper insulated cable construction with the addition of metal tubes laid in the helical valleys between the individual conductors where they in no way influence the dielectric field of the cable. The spiral lay-up of the insulated conductors and the tubes provide alternate high and low points in the tubes which are essential for the proper operation of this cable.

The tubes are filled with a dry inert gas and subsequently perforated in the cable manufacturing operations in such a manner that, during the loading periods of the cable, the insulating oil in the finished cable is forced into the tubes through the perforations, trapping and compressing the gas to a moderate pressure at the high points in the tubes in periodic domes or cushions. This allows for expansion of the insulating oil with increasing temperature without building up the internal pressure of the cable excessively. The perforations of the individual tubes are so arranged that there is always at least one sealed-off gas dome between successive perforations.

Positive Internal Pressures

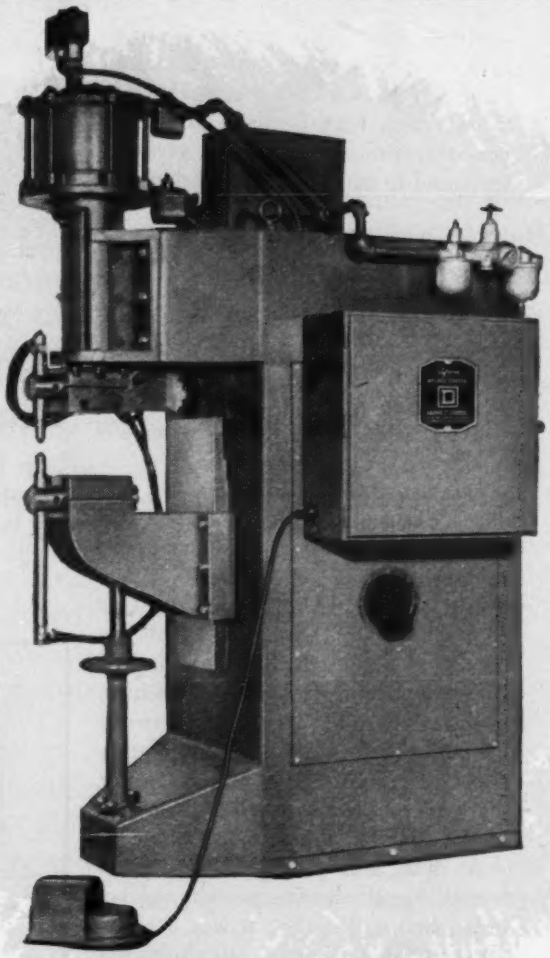
During the cooling periods of the cable, the gas tends to push the oil collected in the tube domes back into the cable structure. In actual operation of this type of cable, it has been observed that the gas cushions do not force all of the oil out of the tubes, so that after the first operational cycle, the inner volumes of the tubes consist of pockets of gas sealed effectively from each other by small pools of the insulating oil located at the low points in the tubes. By proper choice of the perforated tubes and manipulation of the cable during the manufacturing and installation operations, it has been found possible to operate this type of cable under positive internal pressures regulated within predetermined limits, whereby the regulation is effected automatically within the integral cable structure.

This pressure compensated cable, designated type PC by the American Steel & Wire Co., has been under accelerated life tests in the company's research laboratories for more than a year, during which the cable has been operating at 2¼ times normal voltage with an 8-hr. 70 deg. C. copper temperature heat cycle in each 24-hr. period. The observed internal pressure regulation has been within the limits of 15 psi. for the loaded condition, and 5 psi. for the unloaded condition. The equivalent life of this cable under these test conditions as calculated by the sixth power law is now well over 450 volts/mil/hr. with no insulation failures and the insulation showing but slight, if any, evidence of deterioration in the regions of maximum electrical stress. These tests are being continued until actual dielectric failure.

It is anticipated that this type of cable may be installed and handled in the same manner as ordinary solid

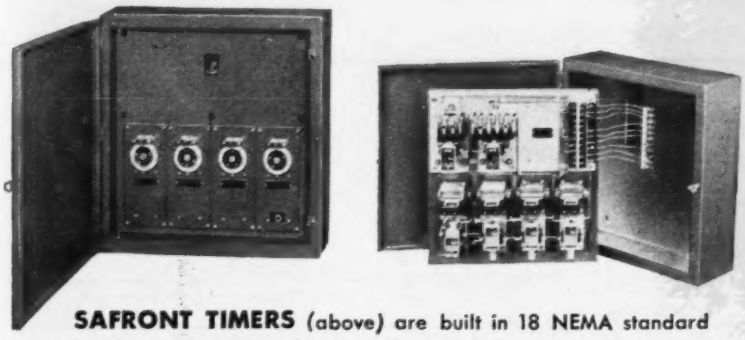
* Research Engineer
† Electrical Engineer

MORE PRODUCTION WITH LESS OPERATOR SKILL *when resistance welders have* SQUARE D *Automatic* CONTROL

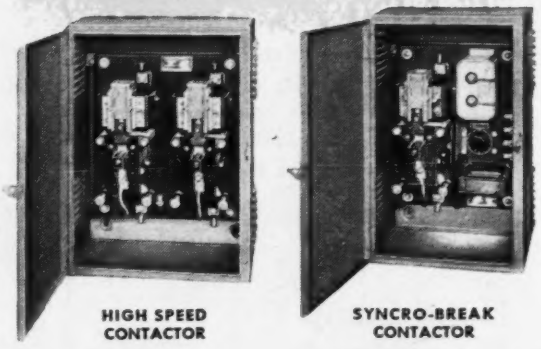


● Consistently good resistance welding at high production rates requires automatic control of pressure and current in an accurately regulated sequence. Square D welder control meets those requirements—exactly. It is simply designed, easy to install and maintain. With Square D automatic control on the job, very little operator skill is required—a vital angle during today's scarcity of skilled manpower.

Specify Safront timers and Syncro-Break or High Speed contactors on new welding machines. Or, if increased quality and production is needed from present machines, find out how easily they can be equipped with automatic control. Consult your nearest Square D Field Engineer.



SAFRONT TIMERS (above) are built in 18 NEMA standard types. Notice, in upper left photo, how all electrically energized parts are behind a protective panel, yet calibrated timer adjustments are accessible on panel front. Separate timing devices, provided for each step of the welding cycle, are individually adjustable from 3 to 100 cycles. Safront interiors "swing out" (upper right photo) to expose operating parts.



HIGH SPEED CONTACTOR

SYNCRO-BREAK CONTACTOR

HIGH SPEED AND SYNCRO-BREAK CONTACTORS (right) possess unusual design features necessary for frequent making and breaking of the welding transformer primary circuit. The Syncro-Break design includes means for opening circuit without arcing at contact tips, thus increasing contact life and allowable ratings.

ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

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type paper insulated cables. Joints may be made by splicing the pressure compensating tubes straight through with tap-offs at the splices for the introduction of gas or connection to pressure indicating and monitoring devices. The pressure compensating tubes may be sealed off completely when splicing pressure compensated cable directly to ordinary solid type cables. For extremely long cable lengths where uniformity of pressure regulation conceivably might be a problem, provisions can be made to introduce a smaller non-perforated tube inside one of the perforated tubes which may be used for unimpeded transmission of gas pressure from end to end of the cable length.

•

Equalized Temperature Stops Penstock Leaks

By J. H. BERTHOLF,
Pacific Gas & Electric Co., Auburn, Calif.

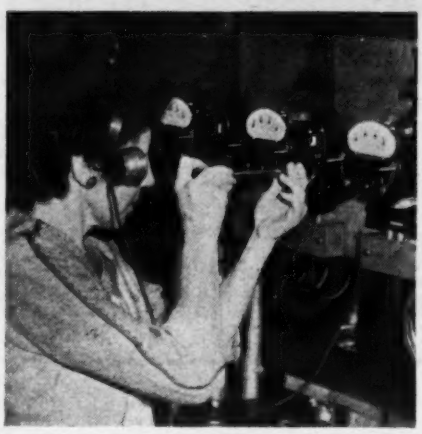
During summer heat, trouble has been experienced with leaks and seepage on the lower cast iron bell-jointed sections of penstock at the Colgate power house of Pacific Gas & Electric Co. Observation of the condition suggested that loosening of the lead packing in joints was due to unequal thermal expansion between the bell and the spigot, the cumulative effect of which would in time cause the lead packing to work entirely out of the joint.

A small but perceptible temperature difference having been noted between bell and spigot, it was decided to paint about 30 bells with aluminum paint. This apparently eliminated the temperature differential as there have been no leaks since. Modern penstocks, of course, have an entirely different type of joint and are not subject to trouble of this nature.

•

Head Lamp Frees Hands

One of the girls working at the gang test bench in the Central Illinois Public Service Company meter shop, Sprinfield, suggested the head lamp pictured above. It frees both hands and still gives the tester supplementary light where it's needed. The lamp part is a flashlight head attached to a spring-steel head band. A cord and two-prong plug connects the lamp to a small step-down transformer under the bench.



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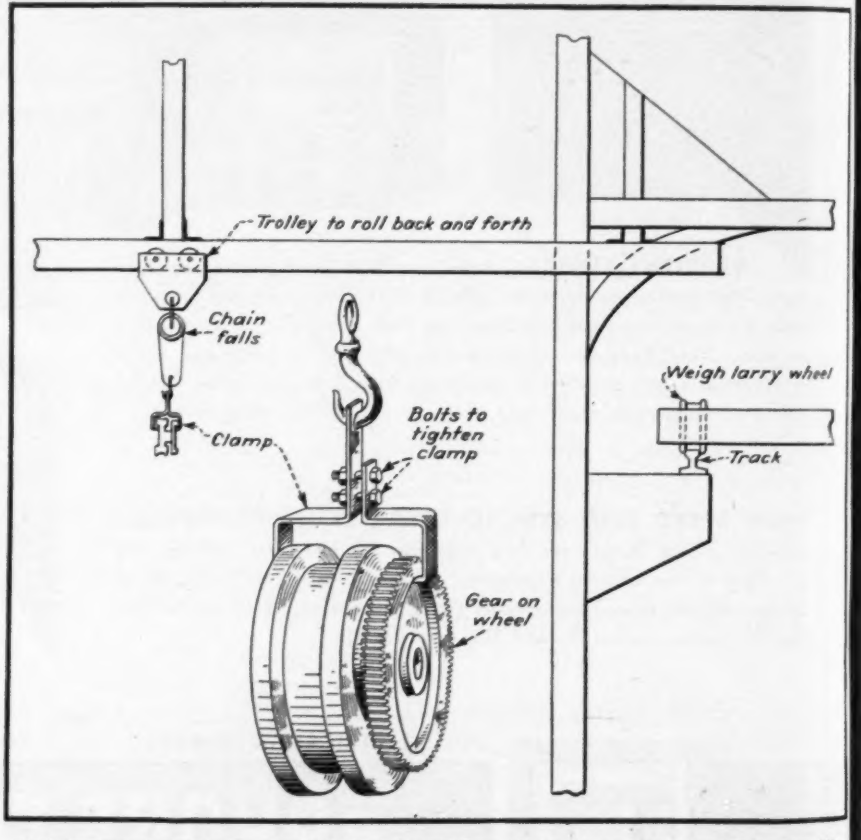
An Improved Plan to Change Larry Wheels

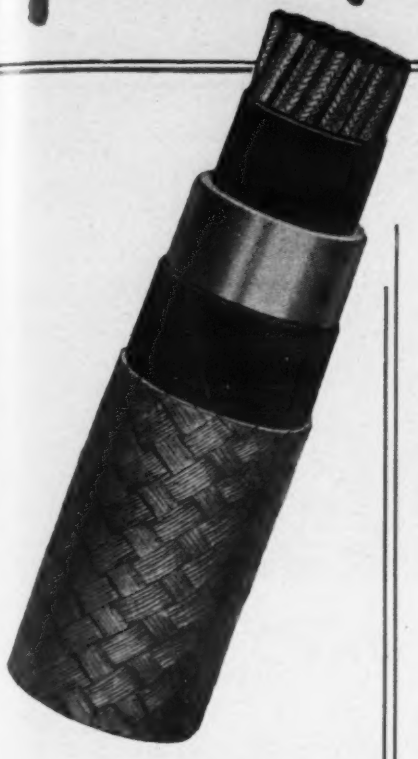
In the steam plants of the United Illuminating Co., New Haven, Conn., an improved method of changing weigh-larry wheels has been designed to speed up and safeguard the work. The wheels, four per car, weigh about 200 lb. each, and their roller bearings have to be replaced from time to time. In the past, it has been necessary in doing this to carry to the boiler top such material as rope, falls, wire slings, timbers. It was necessary to jack up the corner of the larry, attach wire slings, put up a timber support, hook on the falls and lift the wheel by pulling it off center of the top, and then hooking 4 or 5 ft. over to the top of the boiler, replacing similarly. The method was unsatisfactory and somewhat hazardous, as the boiler room floor was 20 ft. under the larry.

In the new scheme the problem will be solved by installing a 5-in. I-beam from the ceiling out over the wheel to the boiler top, with a trolley to which a ½-ton chain falls can be hooked. The wheel in turn can be raised straight up and rolled safely out on the rail to the top of the boiler, saving both time and labor. The wheel will be held by a positive grip clamp in place of the former sling facilities. Thus the changing of these wheels will be made quicker, easier and definitely safer.



ARRANGEMENT of trolley and chain falls with positive-grip clamp to facilitate handling weigh-larry wheels in steam plant

from Training Camps to TOKYO



Simplex-Latox
Shipboard Cable

In cargo and combat ships, in Liberty and Victory ships, in Merchant Marine and Navy ships, thousands of miles of shipboard cables are in use for communication and control of electrical equipment.

Simplex-Latox Shipboard Cables are only one of many types of specially designed Simplex cables used extensively by our Armed Forces and Merchant Marine.

Every step of the way you will find Simplex insulated wires and cables, specially designed for the job they have to do. Camps and equipment need wires and cables for power, lighting and control. Ships must have power and communication cables, planes and tanks must have their quota of electrical conductors. Telephone wire goes forward with every advance into enemy territory. Insulated wires and cables will be needed to establish communication and distribute power in territory now held by the enemy as it comes under our control. All the way from training camps and war industries to Berlin and Tokyo, Simplex insulated wires and cables have a part in military operations that lead to Victory. Simplex facilities are wholly devoted, either directly or indirectly, to war work.

Simplex insulated wires and cables are now made with Simplex synthetic rubber insulations and sheaths. The same technical and engineering skills that made our natural rubber compounds outstanding are now focused on the synthetic compounds that have replaced them. Remarkable results have been obtained and performance records already point to an important future for Simplex "synthetic rubber" insulations and sheaths for power, control and communication cables.

Simplex Wire & Cable Co., 79 Sidney Street, Cambridge 39, Mass.

Simplex
WIRES and CABLES

Methods of Improving Gas Turbine Efficiency

By F. K. FISCHER, Steam Engineer, and C. A. MEYER, Development Engineer,
Westinghouse Electric & Manufacturing Co., South Philadelphia, Pa.

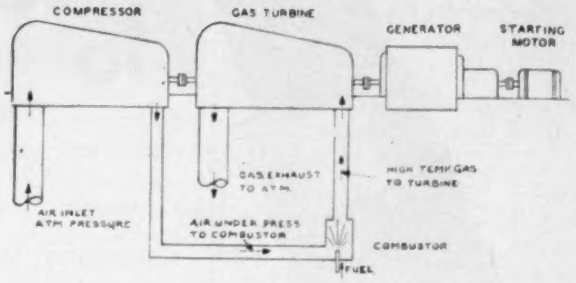
Thermal efficiency of an open cycle gas turbine can be increased by regenerating, intercooling and reheating or by various combinations of the methods. Very large capacity possible by resort to a closed cycle. These methods are shown schematically. For further information see page 52 of this issue.

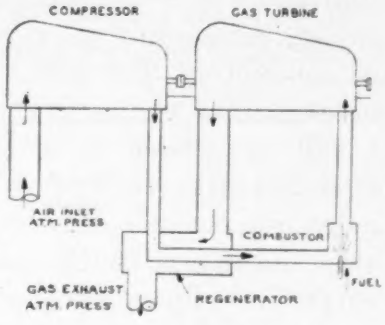
RIGHT—Simple open cycle combustion gas turbine consisting of a compressor, a combustor, and a gas turbine

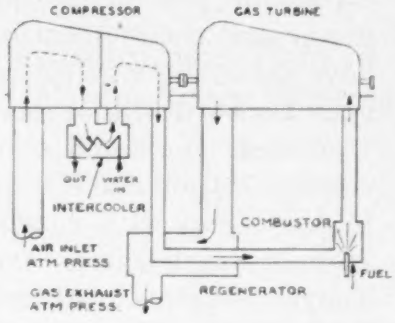
BELOW LEFT—Regeneration applied to open gas turbine cycle

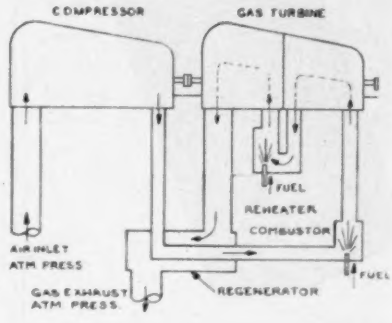
BELOW CENTER—Intercooler and regeneration added to open cycle

BELOW RIGHT—Reheat and regeneration for open cycle



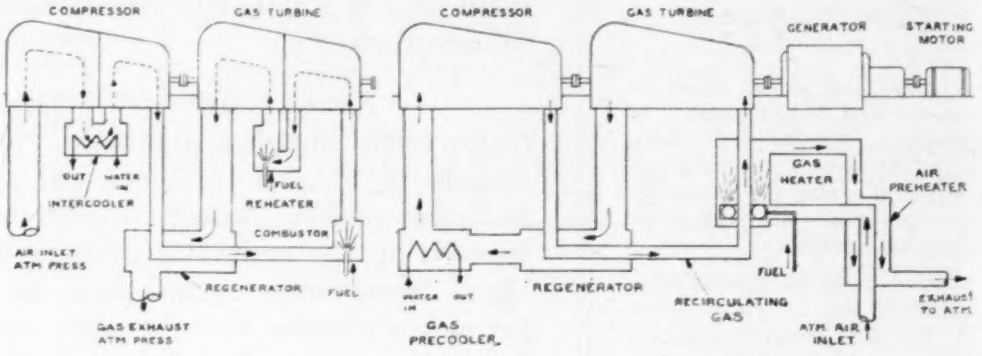






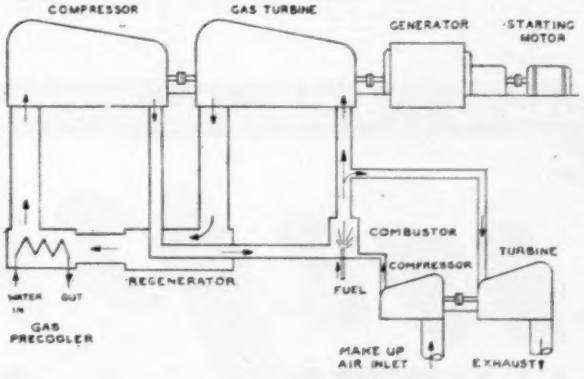
LEFT — Intercool, reheat, and regeneration for open cycle

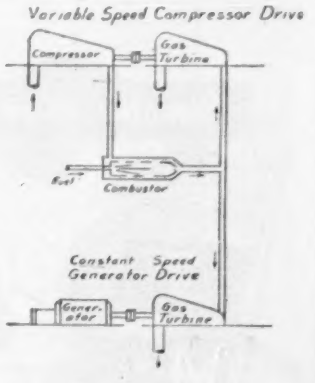
RIGHT—Escher Wyss externally fired closed cycle



LEFT—Proposed internally fired closed cycle

RIGHT — Possible method of gas turbine control combining variable and constant speed drives





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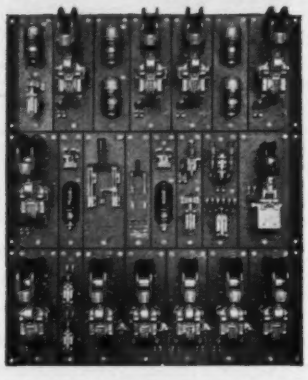
IN HULETT Unloader work, the distance the load travels is relatively short (a round trip from boat-to-hopper-to-boat requiring as little as 48 seconds time). EC&M *LINE-ARC* Magnetic Contactor Control fulfills the requirements of this *high speed operation* in an outstanding manner.

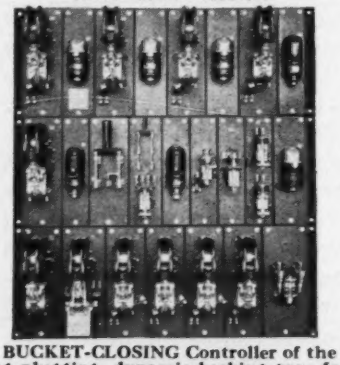
First, EC&M quick-responding *LINE-ARC* Magnetic Contactors permit almost instantaneous movement of the Bucket, Beam or Trolley motions when the operator manipulates his Master Switch. This means greater maneuverability for "clean-up" as well as faster operation for normal unloading.

Second, the *LINE-ARC* principle controls the arc so that contact-life is materially increased and there is no destructive burning of the arc shields. The result is low up-keep cost, due not only to fewer replacements but also to less inspection.

Before purchasing control for ore unloading or ore handling machines, we invite your investigation of EC&M Magnetic Control which uses the *time-saving, economically-operating* *LINE-ARC* Contactors.



Reversing-plugging, dynamic braking TROLLEY Controller. All controllers operated by "short-throw" Masters

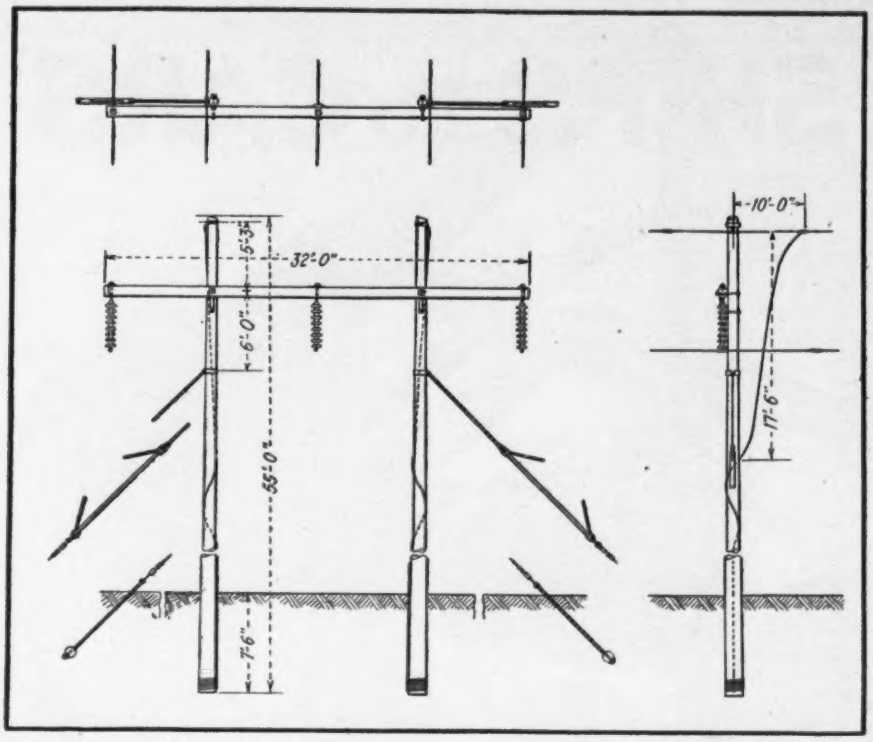


Typical BUCKET-CLOSING Controller of the reversing-plugging, dynamic braking type for Hulett Unloader

E C & M

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, 4 ★ OHIO



TANGENT STRUCTURE for steel conductor transmission tap: poles are class 3 pine, 55 ft., and crossarms are class 4 pine cut to 32 ft.; side guys are used when average of two adjacent spans exceeds 650 ft. or poles set in soft earth

Steel Wire for Transmission Tap

By JAMES A. RAMLS
Construction Engineer,
Virginia Electric & Power Company

The Virginia Electric & Power Company recently installed line and substation equipment to supply 5,000 kw. at 4 kv. to a new customer. The capacity of the low-voltage facilities in the vicinity would not handle the new load, so it was necessary to resort to tapping a 110-kv. transmission line which was about 2½ miles from the load. The importance of the 110-kv. main line to be tapped made it necessary to construct a tap line that would be very reliable so as not to place a hazard on the main line.

In order to conserve critical materials wood "H"-frame construction was used with wood poles for crossarms. Two overhead ground wires of ⅜-in. high-strength steel were installed and a minimum of guying was used. Because of the protection afforded by the ground wires, the insulator strings were hung from the pole arms by eye-bolts through the arms, rather than by using bands, as is our general practice to prevent the arms from splitting due to lightning flashovers. A light steel band, similar to those used for fastening boxes and crates, was placed around the end of each arm close to the eye-bolt to prevent splitting, which would allow the eye-bolt to pull through and drop the conductor.

Calculations showed that steel could also be used to serve as the line conductors and this was done to conserve copper. It was found that ⅜-in. steel wire would carry the current required and experience with ⅜-in. steel wire operating at 110 kv. since 1918 indicated that it would last at least twenty years. In deciding on the kind of steel conductor to use, it was decided that wire having the characteristics of Crapo steel wire, such as is often used in small sizes for distribution, would be the best of the wires considered. The manufacturer agreed to make this wire up in ⅜-in. seven-strand, and it is understood this is the first ⅜-in. wire made up of Crapo steel conductors. The mechanical strength of the wire is about the same as that of standard guy strand (rather than the high-strength strand), which allows the overhead ground wire to be strung tighter than the conductor so as to secure additional mid-span clearance as additional protection against lightning flashovers. The down leads from the overhead ground wires were also ⅜-in. steel strand; thus not a pound of copper was used for the 110-kv. line.

Relaying of the main 110-kv. transmission line is so fast that there is no danger of overheating the steel conductors from fault currents. The line has operated since January, 1943, without a flashover and without any mechanical or electrical trouble.

•

Operate Hydro Units As Condensers

By A. A. TURNQUIST
Operating Engineer, Minnesota Power & Light Co., Duluth, Minn.

Three principal benefits have accrued to Minnesota Power & Light Co. by arranging five synchronous generators at four of its hydro-plants for operation as synchronous condensers during low-water periods. In their order of importance these benefits are: (1) A more efficient use of water during dry periods; (2) improvement in voltage conditions on the transmission system and (3) delivery of wattless current at points near the load thus saving losses.

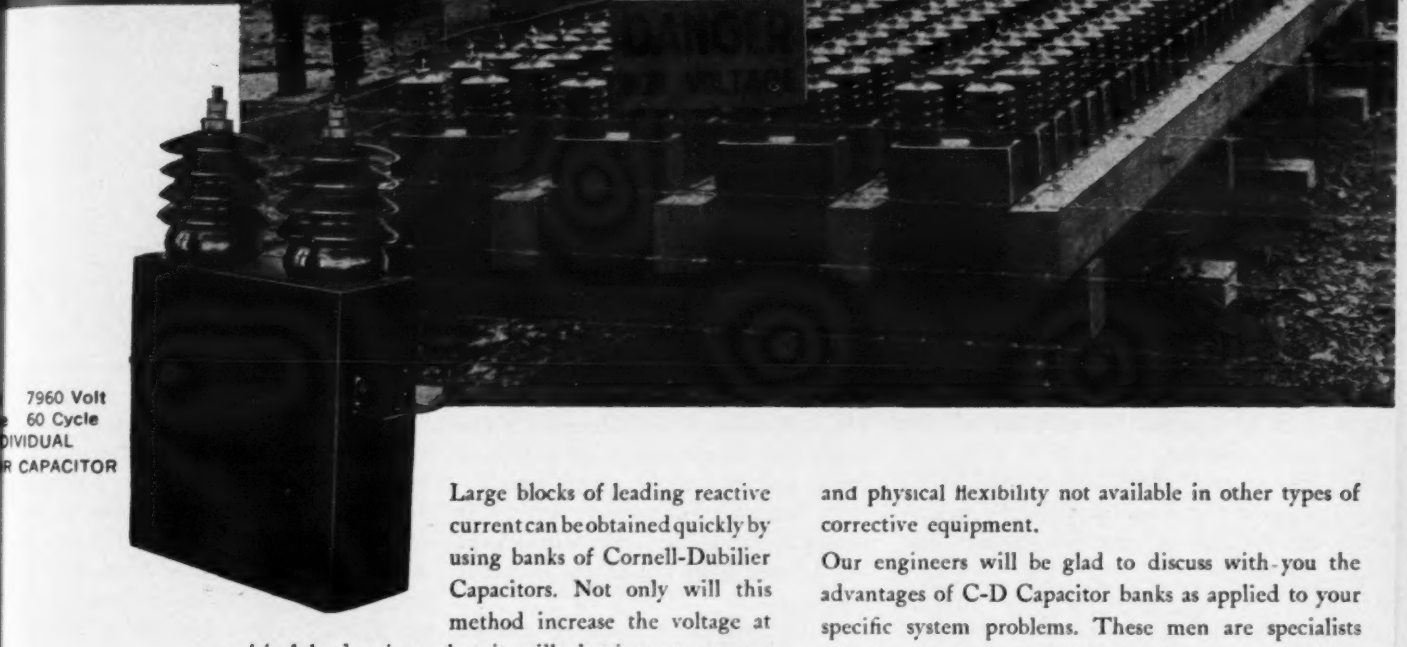
Synchronous generators, motors and condensers are electrically identical in theory. They differ primarily in that the shaft torque of the generator and motor are opposite and that of the condenser is usually zero. To permit use of the hydro generator as a condenser, it was only necessary to unwater the draft tube to prevent suction of water from the tailrace up the draft tube into the wheel of the turbine causing turbulence and drag on the rotor. To do this in the largest machine, a 12,000-kw. unit, an 8-in. pipe fitted with an oil pressure operated valve was run up from the draft tube and vented to atmosphere.

Two 6,000-kw. units were each provided with two 4-in. horizontal valves installed in the cover plate of the scroll case in such manner as to clear the gate-operating mechanism.

An ingenious arrangement was worked out by W. S. Evans, superintendent of hydro electric generation, whereby the movement of the turbine wicket gates operated a pilot valve so that the valves in the vents opened automatically when the wicket gates closed, and the machine operated as a condenser. When operating as a generator, the valves are automatically

PROBLEM: *we need more voltage at critical load point*

ANSWER: *large banks of* **C-D** *capacitors*



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Large blocks of leading reactive current can be obtained quickly by using banks of Cornell-Dubilier Capacitors. Not only will this method increase the voltage at critical load points—but it will also improve system capacity. Many utilities are solving the problem of new, large, concentrated loads by using C-D's in banks of: 8,000, 15,000, 20,000, 40,000 KVA etc. C-D Capacitor banks can be quickly reassembled to provide a variation in the corrective capacity, to conform to load requirements. This affords an electrical and physical flexibility not available in other types of corrective equipment.

Our engineers will be glad to discuss with you the advantages of C-D Capacitor banks as applied to your specific system problems. These men are specialists who help design and build capacitors today for allied war industry and fighting equipment. They have learned a lot from the exacting standards of production for war. This extra talent is yours when you specify C-D — the name that has meant capacitor superiority for 34 years. Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey

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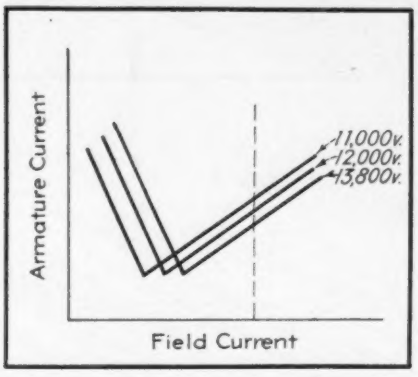
closed. An important feature of the arrangement is that the units are always under governor control. If, while a unit is operating as a condenser, the system frequency should drop to a predetermined value, the vent valves will close automatically and the unit will go into generation and hold the frequency.

During low-water periods, machines equipped for venting may be operated, for example, for 45 minutes of each hour as synchronous condensers and for the remaining 15 minutes as generators in the case of "run of river" plants. Plants operating on controlled storage may be operated approximately 18 hours per day as generators with six hours as condensers. During the generating period the turbine thus can be operated at its most efficient gate opening, resulting in more efficient use of water than would be the case if it was operated for the full period at 0.4 or some less efficient gate opening.



V-CURVES for typical synchronous condenser indicate automatic effect

While the generator is operating as a condenser, it can be effectively used to control the voltage of the transmission system. By adjusting the field excitation of the machine to cause it to consume an appropriate value of leading current, this current, when drawn through the inductance of the line, will raise the voltage enough to obtain the desired value. If the excitation of the synchronous condenser is set at a specific value, it will be seen from study of the V-curves for synchronous condensers that any tendency to pull down plant bus voltage will automatically cause the condenser to take a greater leading current, thereby tending to keep the voltage from falling off as much as it would otherwise.

The condensers, of course, have the usual effect of improving system power factor and, in cases where they are located near large inductive loads, supply the necessary wattless current at the point of use and thus free transmission line carrying capacity and save system losses.

•

Thermoplastic Cable Requirements Met

Polyvinyl chloride, p.v.c., a thermoplastic compound, can be designed to meet specified cable requirements, but much depends upon the testing technique employed to evaluate these requirements, according to a paper presented before the (British) Institution of Electrical Engineers by H. Barron (Pirelli-General Cable Works, Limited), J. N. Dean, (Telegraph Construction Maintenance Co.), and T. R. Scott, (Standard Telephones & Cables, Ltd.).

In the thermoplastic group, p.v.c is given special consideration due to its outstanding qualities of resistance to sunlight, oxidation, fire and a large variety of chemicals, including oil. P.v.c. may be applied to the cable in three ways.

1. Longitudinal - strip application. This process depends on self adhesion of materials, a property in which p.v.c. is lacking, therefore causing the cable manufacturer to do considerable development work. Success has been attained with braided p.v.c. cable and development work is now being carried on with taped cores.

2. Taping. Not used to any great extent in Britain but successfully used on certain types of cables in other countries.

3. Extrusion. The normal method of applying insulation and the sole method of sheathing cables. P.v.c. is easy to extrude and very fine results are obtained in concentricity, thin walls, etc.

Polyvinyl-chloride sheathed cable has been successfully installed on board ship, in building construction and in aircraft. One method of joint installation is to use a paste, made by dissolving p.v.c. in cyclo-haxanone; it is pressed into the joint area where the joined conductors lie in a split sleeve. The whole is then taped with three proofed tapes, proof-side down, and heated by means of a small flame until the outer tape changes to a creamy brown. The tapes are then removed.

P.v.c. is unlikely to be used as an insulant for frequencies in excess of 2 kc. since the dielectric loss of the material is high and is extremely variable with frequency and temperature. Where a high-insulation-resistance thermoplastic cable is needed a nonpolar material such as polythene is used.

•

Acid Superior in Electrogalvanizing

An acid is better than a cyanide electrolyte for electrogalvanizing because higher current densities may be used, which, together with higher cathode efficiencies, afford faster plating. This fact and the statement that the cost of maintenance is lower than with cyanide baths is made in a paper by E. H. Lyons, Jr., chemist, the Meaker Co., Chicago, and presented before the Electrochemical Society.

The strip to be galvanized is passed, usually horizontally, through the bath with the anode either above or below it. Usually one side is done at a time, and the strip if narrow, is twisted 180 deg. in the center of the tank in order to treat the reverse side.

Box strapping, barrel hooping, strip for "BX," and such products are galvanized in the widths to be used.

Current densities usually average from 110 to 150 amp. per sq. ft. of exposed surface to the anode. Contact to the strip is made by copper rollers or bars carefully shielded from the anodes. The weight of the strip sliding over a contactor bar is not sufficient to secure a good contact; therefore a "hold-down" roll or a finger type contact is advantageously employed.

Because of the wide variations in tank sizes, strips, and weight of coating to be applied, it is not possible to state typical speeds or currents. Some machines, applying "2 test" coatings, run at from 40 to 80 ft./min. and produce about 35 tons (more than 400 miles) of "BX" strip in 24 hr. Speeds as high as 150 ft./min. have been reached on materials where light coatings are desired. From ½ to 1 gallon of electrolyte is provided for each ampere of plating current to minimize composition changes and facilitate cooling.

After electrogalvanizing, the strip is carefully rinsed, dried and coiled ready for shipment.

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PHILCO FLOTÉ BATTERY TYPE 9 DF

WITH the famous Philco Floté element—the only battery construction specifically designed for full float service—low cells are eliminated. High capacity, superior conductivity and efficient current distribution are assured. It is a known fact that the special metal in which Floté grids are cast reduces the amount of current needed to maintain the charge by 40%! And the less current your stationary batteries require to maintain their charge, the longer service life you get. Philco Floté grid design is today's answer to dependable service and long life. For control and stand-by service, Philco Floté Batteries in Steel Glass jars are available in cell capacities from 10 A.H. to 1056 A.H. Write for Control and Auxiliary Power Battery catalog.

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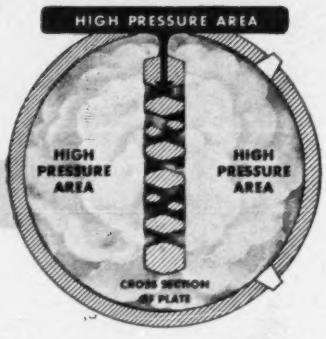
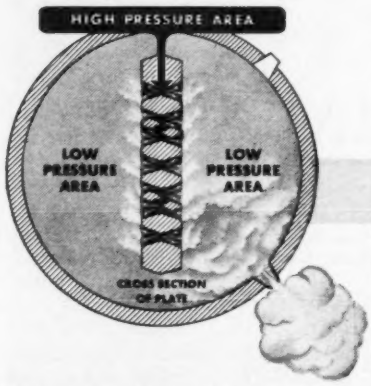


FAMOUS "K" PROCESS

produces plates far superior in hardness, porosity, durability



1. Plates packed with active material (Flake Oxide) are hung in the chamber of the "K" Dehydrator. Super-heated steam is introduced and sealed into the chamber so that it surrounds all surfaces of each plate uniformly, creating a high pressure area around the active material in the plate. The steam also permeates the active material until the pressure within the plate equals that of the steam in the chamber. The moisture within the active material is also changed to steam during this part of the process.

2. Steam is released from the chamber, restoring the low pressure area around the plate. The steam pressure within the plate then forces the active material firmly and evenly against the grid members, assuring greater *conductivity*. As the steam which has permeated the active material escapes, it forms large numbers of tiny channels from the center to the surface of the plate, creating exceptional *porosity*. Drying has been uniform, which prevents surface cracking and assures equal consistency throughout the plate.

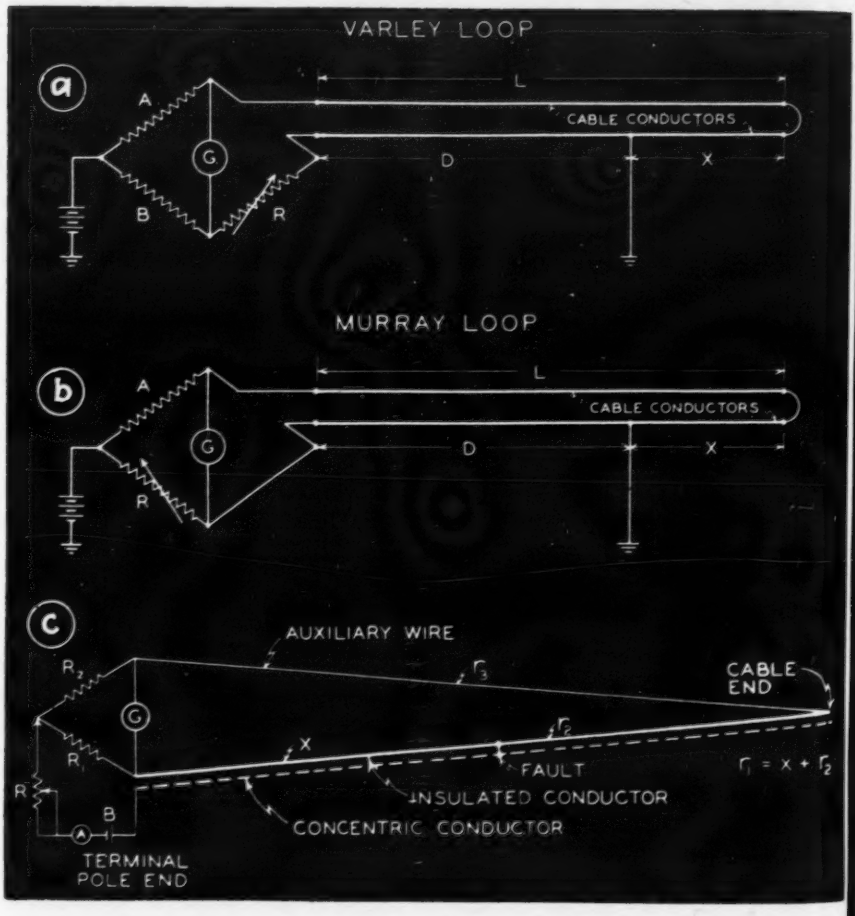
FAULT LOCATION ON NON-METALLIC SHEATH CABLE

By H. N. EKVALL, Engineering Department, Philadelphia Electric Co.

The Communications Committee of the Pennsylvania Electric Association at the request of the Electrical Equipment Committee recently undertook a study of various methods for locating faults in non-metallic sheath power cables and control wiring. A brief resume of this study places the various fault locating methods into three groups. The first group, Electric Pick Up Methods, was presented in ELECTRICAL WORLD, April 1, 1944 issue, page 82. The second group is presented here, and the third group, Miscellaneous Methods, in which is included ways of fault location not previously discussed, will follow in a subsequent issue.

GROUP II—BRIDGE METHODS FOR LOCATING FAULTS TO GROUND

Note: The fault should be burned down to a sufficiently low resistance to obtain ample testing current. Also the length of the conductors and resistance per unit length must be known.



(a) VARLEY LOOP—When the bridge is balanced the value of R is equal to the loop resistance ($2X$) of the circuit from the fault to the distant end, if the A and B arms are equal. Both conductors are assumed to have the same resistance per unit length.

(b) MURRAY LOOP—When the bridge is balanced the resistance X to the fault is determined from the following:

$$\frac{R}{A} = \frac{D}{L+X}$$

Both conductors are assumed to have the same resistance per unit length.

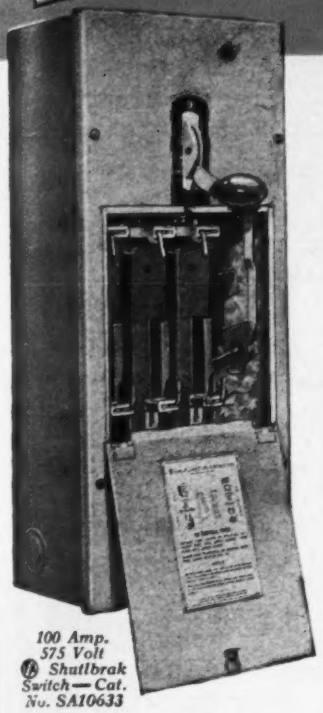
(c) BRIDGE METHOD ON CONCENTRIC CABLE—When bridge is balanced the distance to the fault is determined from the following:

$$\frac{R_2}{R_1} = \frac{(r_1 - X) + r_3}{X}$$

One difficulty is this scheme requires use of auxiliary wire.

DANGER

SAFETY— with a capital "S"



100 Amp. 575 Volt (FA) Shutlbrak Switch—Cat. No. SA10633

In each unit, the roller type main contact and auxiliary contacts are enclosed in an insulated shuttle. Shuttle assembly is entirely surrounded by insulating material.

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There is an arc-resisting barrier *at all times* between the line and load contacts.

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(FA) Kamklamp fuse-holders assure copper-to-copper connection *under strong compression.*

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Properly engineered springs insure quick make and quick break.

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All current-carrying parts are silver plated for low resistance.

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(FA) Pressure type (Solderless) Connectors make possible quick, sure connections. There is ample wiring space at top, bottom *and rear* of switching mechanism.

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Unit capacities: 30 to 1200 amperes, inclusive, for 250 volts AC or DC, and 575 volts AC, in 2, 3 and 4 pole types.

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(FA) Shutlbrak Switches are approved by Underwriters' Laboratories, Inc.

SAFETY IS THE PRIME FACTOR IN THE DESIGN AND CONSTRUCTION OF

(FA) SHUTLBRAK SWITCHBOARDS and PANELBOARDS

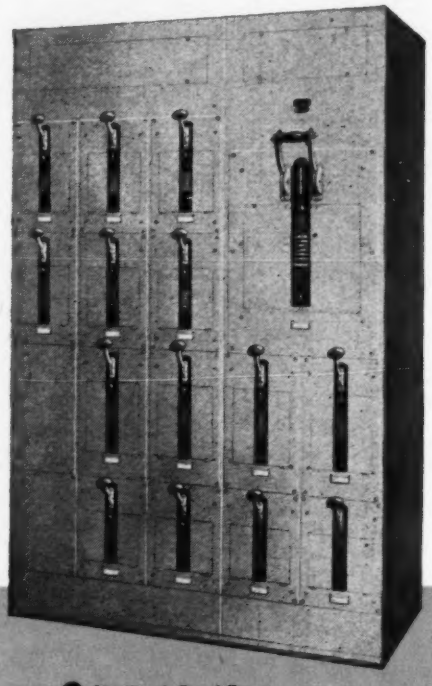
Protection against contact with live parts is assured. The switching mechanisms are completely enclosed. The door of each Type A unit has an interlocking arrangement which prevents it being opened when the switch is "on." When the door is open, the current is "off"— thus eliminating the danger element.

Unit construction of (FA) Shutlbrak Switchboards makes expansion of facilities easy and economical. End walls are removable, for placing additional panel sections at either or both sides. Ample size pull boxes are integral with each section.

The same units are used in the assembly of (FA) Shutlbrak Feeder Distribution and Power Panelboards, enclosed in steel cabinet, with door. Ideal for commercial installations, schools, institutions, etc.

For detailed information

and suggested specifications for (FA) Shutlbrak Switches, Switchboards and Panelboards, write for illustrated Bulletin 70 . . . Frank Adam Electric Co., Box 357, St. Louis, Mo.



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Diameter Of Stranded Cable By Slide Rule

By JOHN L. SKEEHAN
Baden, Pa.

To determine quickly the outside diameter of stranded copper electrical cable when no handbook or catalog information is immediately available, a method has been developed which utilizes a slide rule. The method may be used for both concentric and rope-lay stranded cable and requires only three settings on the slide rule for a specific cable size.

Basis for the slide rule method is the following coincidences observed in the table of capacities and diameters of cables (ELECTRICAL WORLD, April 15, 1944, page 136) and formulas:

Outside diameter of 1.3 $\overline{M}$cm (1,300,000) concentric strand cable is 1.31 in.

Outside diameter of 1.75 $\overline{M}$cm (1,750,000) rope stranded cable is 1.75 in.

K = Number of millions of circular mils ($\overline{M}$ cir. mils) in the cable, the diameter of which is required

D = Diameter in inches of cable of K (millions of cir. mils)

D (concentric stranded cable) =

$$1.31\sqrt{\frac{K}{1.30}}$$

D (rope stranded cable) =

$$1.75\sqrt{\frac{K}{1.75}}$$

Concentric Stranded Cable

Outside diameter of concentric stranded cable in sizes from No. 20 (7 or 19 wires) to 5 $\overline{M}$ cir. mils (169, 217, or 271 wires) can be determined as in the following example.

Example — Determine the outside diameter of 2 $\overline{M}$ cir. mil (91, 127, 169, or 217 wires) concentric stranded cable.

1. Set runner over 1.31 in. on the D scale.
2. Move the slide so that 1.30 on the B scale is directly above.

Hold the slide there.

3. For 2 $\overline{M}$ cir. mils move the runner to 2 on the B scale.
4. Read on the D scale 1.63 in. outside diameter.

Similarly for 500,000 cir. mil (19, 37, 61, 91 wires) cable use the same factors as above, set the runner and slide as in steps 1 and 2, then move the runner to 5 on the B scale (right hand end) and on the D scale read 0.81 in. outside diameter.

If accuracy within 1 percent is satisfactory, use the factor 1.30 on both scales.

Rope Stranded Cable

For a given wire area rope stranded cable has a larger outside diameter than concentric stranded cable, e.g., the outside diameter of 1.3 $\overline{M}$ cir. mil rope stranding is 1.50 in. as against 1.31 in. for concentric stranding.

The slide rule method for determining the outside diameter of No. 8, 7x19 (133 wires), to 5 $\overline{M}$ cir. mils, 19x91 (1729 wires), rope stranded cable is similar to the method for concentric stranded cable and is explained as follows:

By setting 1.75 on the B scale over 1.75 in. on the D scale, readings of $\overline{M}$ cir. mils on the B scale will match diameters (in inches) on the D scale.

•

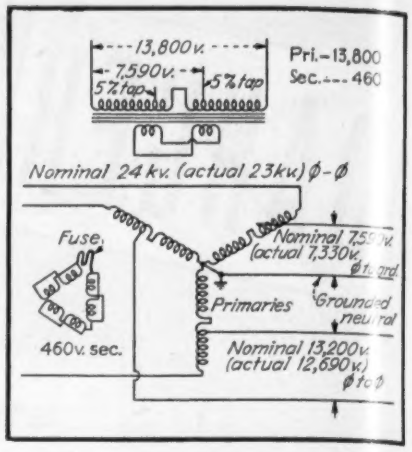
Auto-Transformation Meets Voltage Problem

Faced with a request for 7.2/12.5-kv., three-phase, four-wire service from a nominal 24-kv., three-phase, three-wire, grounded-neutral transmission circuit recently, and having no transformers available for this combination of voltage conditions, engineers of the Oklahoma Gas & Electric Company resorted to a three-phase auto-transformer connection of three available 150-kva., 13,800/460-volt shell-type transformers.

Under normal conditions a 24/7.2-kv., delta-wye bank would have been purchased and installed to meet this service request; however, a low priority and long delivery interfered with conventional solution.

Fortunately three 150-kva., 13,800/460-volt, shell-type transformers, already mentioned, were available with two 5 percent taps brought out of the primary windings, one on each side of the two high side cores. If the two primary windings were connected in series across 13,800 volts a voltage of 7,590 could appear between one terminal of one winding and the 5 percent tap on the second winding, as shown.

Thus by connecting the primary of the three single-phase transformers in wye, grounding the neutral and bringing out phase connections to the nominal 24-kv., three-phase, three-wire



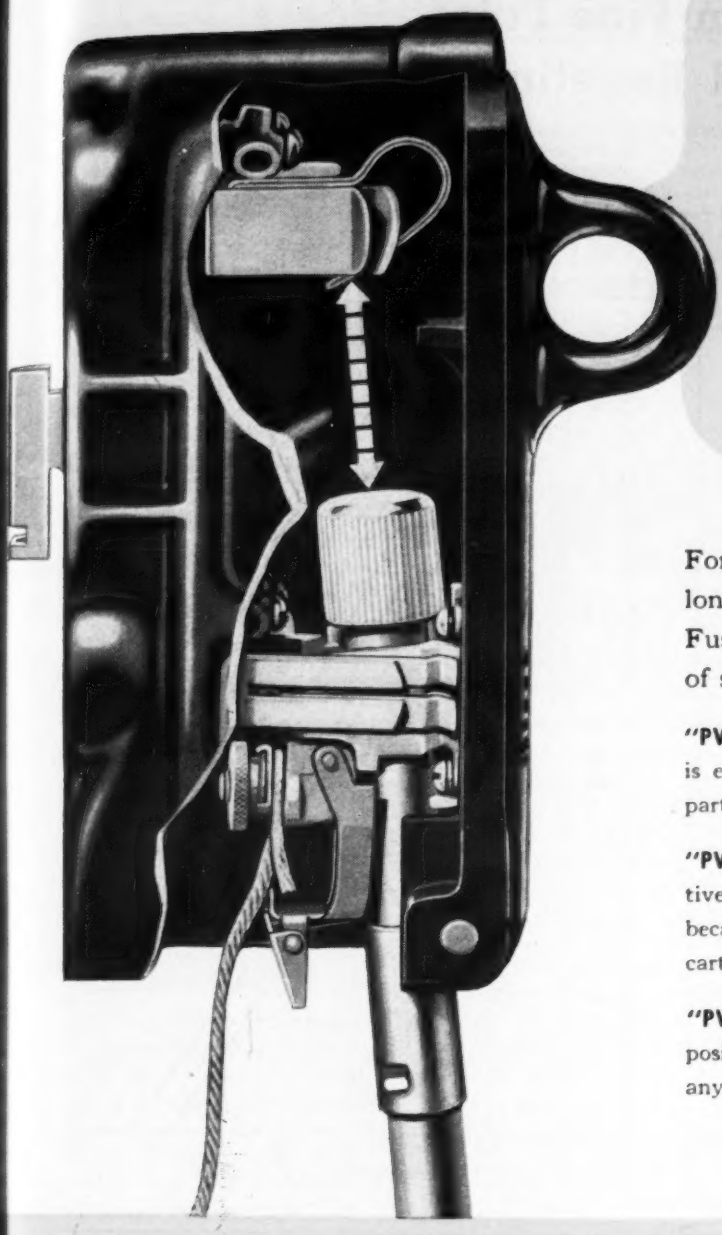
SUPPLY 7.2/12.5-kv. three-phase, four-wire service from nominal 24-kv., three-phase, three-wire grounded neutral circuit by auto-transformer connection of primaries in three 13,800/460-volt transformers

transmission circuit, 13,800 volts was impressed across the primary windings from phase to ground. Accordingly by bringing out the proper 5 percent tap on each transformer primary a 7,590/13,200-volt, three-phase, four-wire system could be obtained, as required. Actually, however the delivery voltage on the nominal 24-kv. line was 23 kv., giving 13,280 volts to ground and 7,330/12,690 volts on the taps, which was "close enough" to the required service voltage.

It was necessary to close the 460-volt secondary winding of the transformers in a delta and install a properly selected fuse in one corner of this delta to protect against certain types of fault or fuse operation. If the secondary winding had not been closed, to provide a short path for the triple harmonic element in the excitation of the grounded wye, the triple harmonic would have established a return path through ground and given rise to an inductive co-ordination problem.

It is to be particularly noted that the arrangement used would not have worked had the transformers been core-type instead of shell-type units. In a core-type transformer it would have been undesirable to arrange the primary coil sections in series because of the unbalanced ampere-turns in the two primary coil sections.

One weakness of the scheme is the hazard introduced by the absence of end-turn insulation at the taps. Normal design would not provide such insulation on a conventional transformer of this type.



Check These THREE Big Advantages of L-M "PVD" Fuse Cutouts

For more complete protection of your lines, long life, and quick, easy re-fusing, L-M "PVD" Fuse Cutouts have proven themselves in years of satisfactory operation.

"PVD" KEEPS THE DOOR CLOSED: Operation of the cutout is entirely independent of door movement and working parts are protected at all times.

"PVD" TAKES CARTRIDGE OUT OF THE CIRCUIT: Arc is positively extinguished before any contacts move or separate because flip-out device pulls the link apart and out of the cartridge tube.

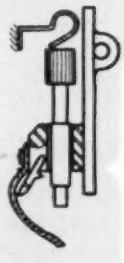
"PVD" PROVIDES PLAINLY VISIBLE INDICATOR: Tell-tale position of dropped down cartridge is readily visible from any direction and from a distance.

For full information write to:
Line Material Company, Milwaukee, Wis.

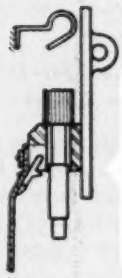
Here is cycle of operation of "PVD" Fuse Cutouts

This view shows L-M "PVD" Fuse Cutout before fuse is blown.

When the fuse blows, the link flip-out device assures instant separation of the blown fuse link parts before the latching lever releases the tube to indicating position . . . a positive time delay.



Latching lever releases tube, upper contact follows tube assuring clearing of arc before contacts separate.



Dropped out position of cartridge acts as visual indicator. Wide air gap between contacts prevents arcing.

L-M DISTRIBUTION EQUIPMENT INCLUDES:
Transformers · Fuse Cutouts · Lightning Arresters · Oil Switches · Pole Line Hardware · Line Construction Specialties · Underground Equipment · Fibre Conduit · Street Lighting Equipment

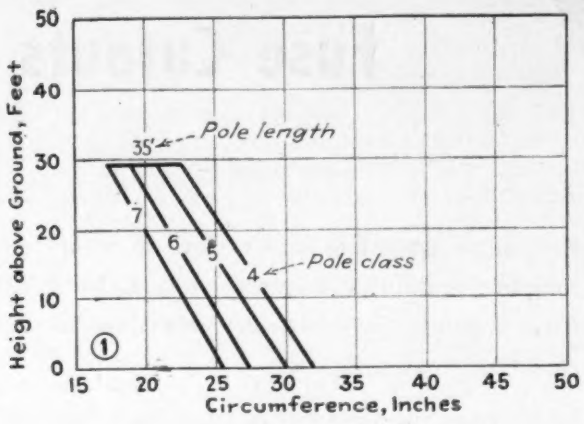
LINE MATERIAL COMPANY
FUSE CUTOUTS

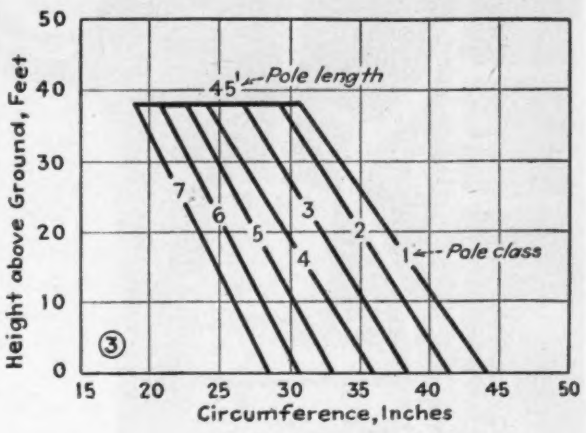
Southern Pine Poles
Dimensions and Resisting Moments

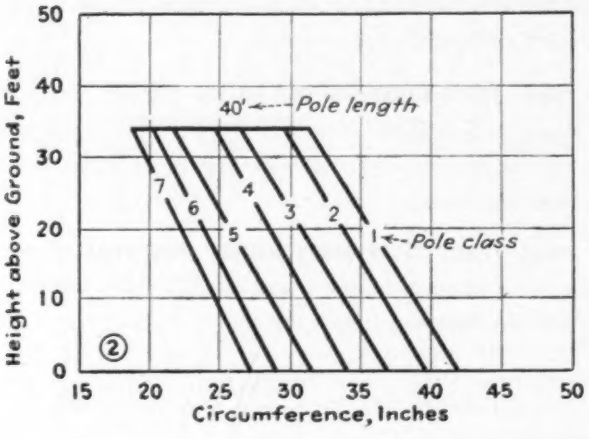
The class, height and type of a given pole being known, the circumference of the pole at any point above the ground line and the resisting moment about that point can be found from this series of charts prepared by the engineering division of the Detroit Edison Co. Used for field estimating purposes these graphical aids have replaced a bulky set of tables which were formerly used for the purpose.

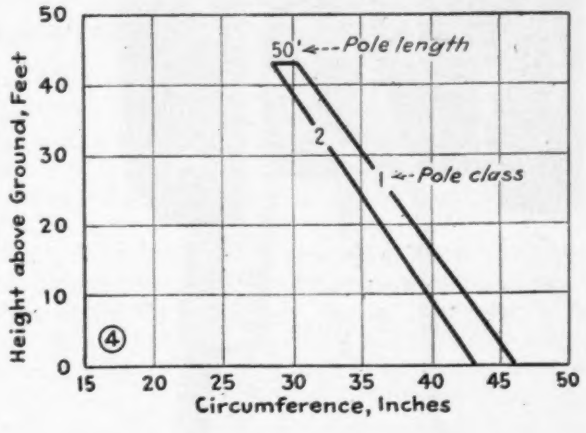
Circumference values from the charts represent average values within the range of tolerance permissible for each pole class. Values are considered sufficiently accurate for field estimating purposes.

POLE DIMENSIONS





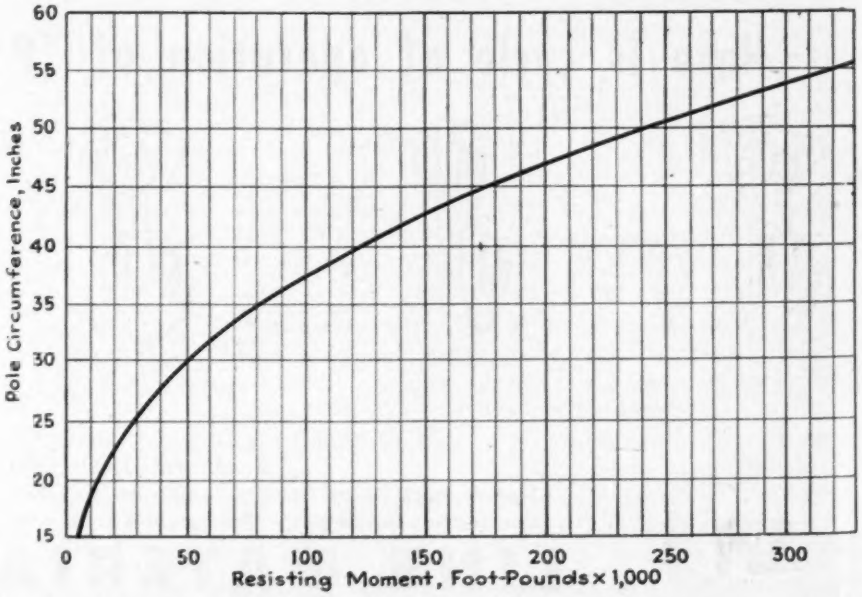




Instructions for Use of the Charts

Determine circumference of a pole at a point above the ground for the class and length of pole from charts 1, 2, 3 and 4.

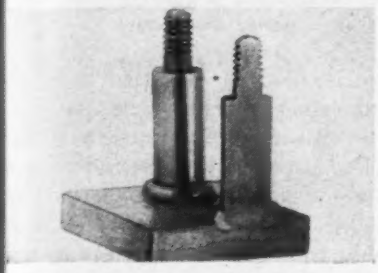
Resisting moment is determined for the respective circumference of the pole from chart at right.



Welds in less than 1/2 second with this proven stud welding process!

The Nelson Stud Welder gives you a dependable means of end-welding studs to metal surfaces—saves your time, material, and labor!

Five years of successful operation has proven the Nelson stud welding process to be a simple, flexible means of end-welding studs to metal surfaces. By its automatic performance an operator can make from 500 to 1,000 welds on a shift—today over 200 industrial plants are using it to help solve production and design problems. Here's how it works . . .



Complete fusion of the stud to metal *(as illustrated)* is the result of the use of Nelson "flux-filled" studs and a patented porcelain ferrule which gives a full shielding of the arc. The strength of the weld is in the strength of the stud—as the stud will break before the weld.

Studs up to 5/16" in diameter can be welded on 16-gauge plate . . . studs up to 1/2" diameter welded on 10-gauge plate.

Flux-filled studs are patented by Nelson. Their unusual construction produces a stable arc that is both concentrated and consistently hot. A patented porcelain ferrule keeps the arc concentrated within the weld area, excluding oxygen, etc., from the molten metal and forms a mold to hold the weld material in position.

The Nelson Stud Welder is fully automatic in operation. The stud is placed in the chuck, the ferrule is placed over its end and the unit contacted with the metal. The operator pulls the trigger which causes the stud to lift a predetermined distance establishing an arc from the stud to the plate. At the end of a predetermined time the gun trips automatically forcing the stud into the molten puddle of metal and the operator is now ready to make the next weld.

With a rag impregnated plastic body the welder weighs only 5 lbs. and is strong and sturdy in construction.

How Others Use Nelson Studs

Installing electric wiring conduits and hangers • Securing all types of insulation materials • Securing machinery of all types • Securing parts to steel castings of all types • Any task calling for end-welding of studs to metal.

Types of Nelson Studs

Shoulder Studs

Shoulder studs in overall lengths of 1" to 8", and 7/16" and 1/2" in diameter. Threaded extension diameters of 1/4", 5/16" and 3/8" with lengths of 1/2" to 1".

Straight Studs

Straight studs in lengths of 1" to 8", and in diameters of 1/4", 5/16", 7/16" and 1/2". Maximum thread length is 1¼".

Drive-in Studs

A drive-in screw is manufactured with a 1½" diameter washer attached. This is used with a female stud, the drive-in screw being driven in after the stud is in place. This type of stud can be used also to secure insulation materials of all types.

Many other types and styles are available for special installations. Let us know your stud welding problems and permit us to advise you . . .

For samples, complete details and catalog, write to:

NELSON SPECIALTY WELDING EQUIPMENT CORP.
Dept. EW, 440 Peralta Ave., San Leandro, Calif.

Eastern Representative: Camden Stud Welding Corp., Camden, N. J.

NELSON STUD WELDERS & STUDS

Care of Resistance Welding Equipment

By E. R. SPITTLER
Works Laboratory, General Electric Co., Schenectady, N. Y.

Both welding quality and production requirements are so exacting today that no part of resistance welding equipment can be expected to deliver the proper standard or quality of work if it is in need of repair or adjustment. A regular schedule should be maintained whereby a periodic inspection can be made for parts that need replacement.

Obviously the object of this short article is not to give detailed recommendation on the proper maintenance procedures, but rather to point out those units that require special attention. Detailed information on the installation, inspection, maintenance, and trouble shooting of individual units can be obtained from manufacturers.

Transformer—If the welding transformer is water-cooled, be sure that free circulation of water takes place at all times during the operation of the machine. Remove all dirt, dust, and grit from the transformer and secondary circuit at least once a week. An accumulation of flash particles will cause a short circuit in the transformer winding, thus reducing its efficiency, increasing operating costs, and eventually causing the tranfsormer windings to burn out.

Switches, Contactors, Timing Devices—These are the nerve centers that control the operation of a welder and, consequently, must always be in good condition, mechanically and electrically, to assure efficient operation. They should be checked every two months for evidence of wear, such as oxidation at fuse connections in switches, loose electron tube sockets, and loose wiring in timing devices.

Electrodes or Dies—Electrodes, welding wheels, dies, or mandrels that have become burned or pitted with steel are a constant source of trouble. Frequent refacing of the working surfaces of these electrodes is excellent insurance against poor welds.

All electrodes and welding dies should be cooled by some method. If water is used as a cooling agent, a full flow should always be maintained while the machine is in operation.

Clamps and Fixtures—The accuracy of the welded assembly can only be as good as the fixture holding it in place during the welding cycle. It is evident that close inspection and frequent adjustment of the fixtures must be made.

Motors and Drives—Motors, variable-speed drives, clutch and reduction units, and transmission gears and shafts, being essential to the proper operation of the welder, should be inspected and adjusted or overhauled as often as necessary, the frequency depending on the production load.

Oiling—All moving parts must be oiled and greased at regular intervals to assure smooth, even motion and minimum wear. Avoid dropping oil or grease on any of the electrical wiring or connections.

Pressure—All welding machines have some device for establishing welding pressure. Usually this consists of an air or hydraulic cylinder, or a cam or toggle with spring arrangement. This system should be inspected periodically and kept in perfect condition at all times. All air and oil filters should be cleaned at regular intervals.

•

Turn Ratio Meter for Transformers

By R. L. MURRAY*

A portable instrument has been developed for determining the turn ratio of power and distribution transformers. It will also reveal short circuits, open circuits, reversed polarity and shorted turns. This instrument is moderately rugged, extremely accurate and can be used anywhere in the shop or field where a 60-cycle, 110-volt source of power is available.

*Adapted from paper at recent conference of Doble Engineering Co., Clients.

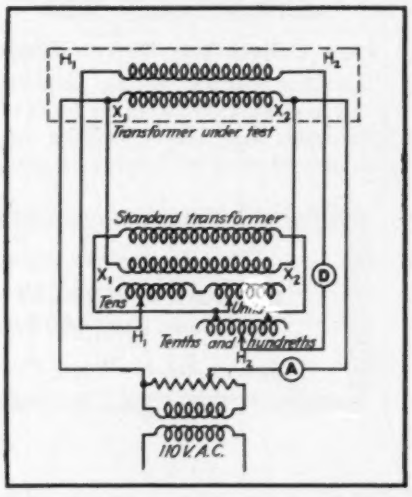
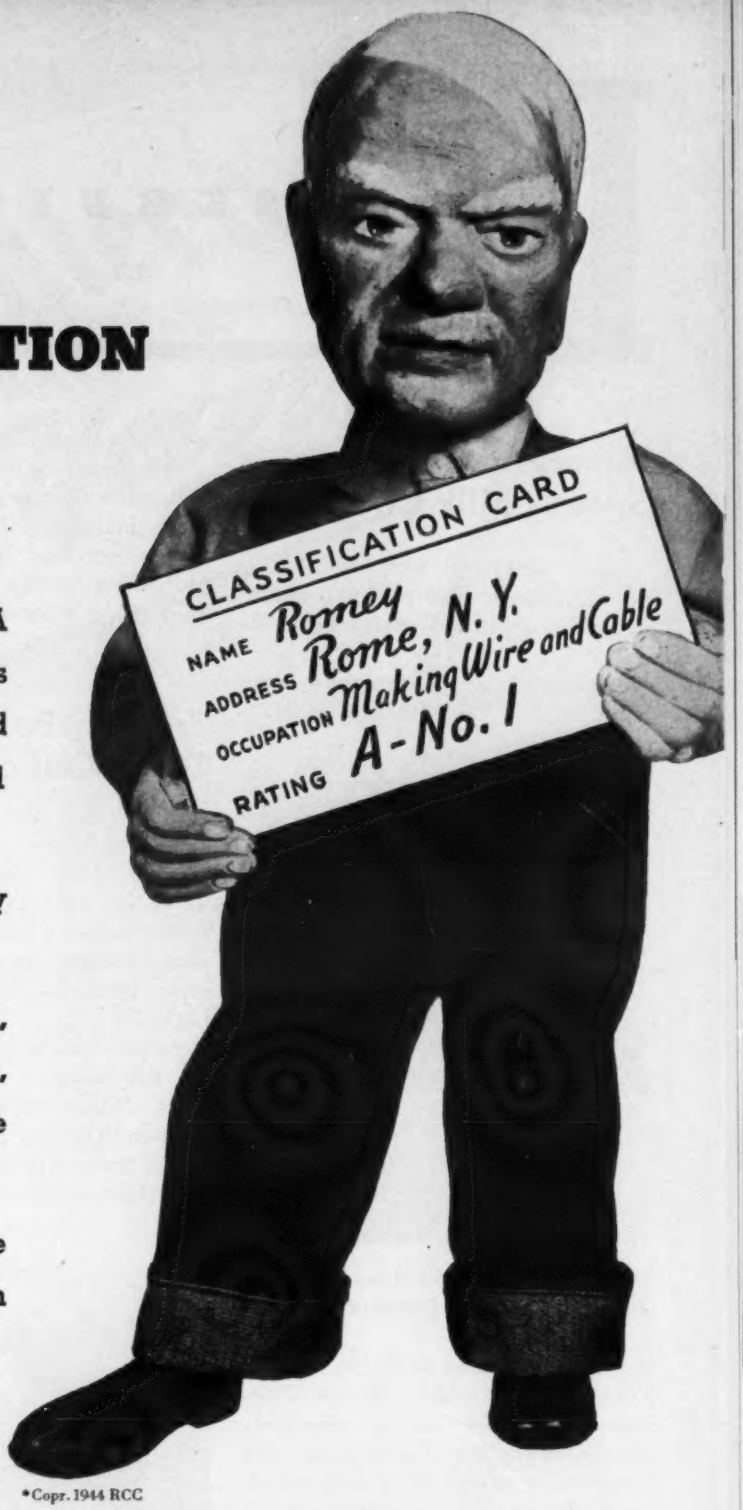


FIG. 1. Instrument determines turn ratio and reveals short and open circuits, reversed polarity and shorted turns

FIG. 2 Field or shop instrument is rugged and accurate and can be used wherever 110-volt source is available. The author, who developed it, is shown making a field test on a power transformer

The instrument has been developed upon the principle that, under no load conditions, the voltage ratio of a power transformer is equal to its turn ratio. This principle is applied as shown schematically in Fig. 1. The low voltage winding of the transformer under test is excited in parallel with the low voltage winding of a calibrated variable ratio standard transformer. When the ratio of the standard transformer is adjusted to equal the ratio of the transformer under test, a null will be indicated by the detector located in the parallel connection of the high voltage windings of the two transformers. The standard transformer is so designed that its error-producing characteristics will cancel the like effects of the transformer under test. The instrument reads ratio direct to four figures for ratios above 10:1 and to three figures for ratios below 10:1 and its range is from 1.00:1 to 111.20:1. The instrument is normally accurate to within one part in two to three thousand. It has proven its merit by about 15 years of constant shop use and has been used satisfactorily in testing all kinds of transformers from the smallest distribution to the largest power types.

RŌMEY'S* CLASSIFICATION is "A-No. 1"



Romey's mature age takes him out of the 1-A classification for selective service . . . but his many years' experience in making wire and cable gives him a special rating of A-No. 1 in our plant.

Wire is one of the products most urgently needed by the armed forces.

So . . . Romey is using his skill, knowledge, background and energy in rolling, drawing, annealing and insulating on the vital home front.

He's a good chap to know and he will be glad to discuss electrical conductors with you any day.

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Motorized Stirrer Speeds Milk Cooling

More than 100 homemade milk stirrers, like the one pictured, are in operation on Illinois dairy farms in the territory served by Public Service Company of Northern Illinois. Users report that the device effectively speeds the cooling of milk from body temperature to well-water temperature for shipment.

HOMEMADE milk stirrer of the type that is proving popular on Illinois dairy farms

The design was developed by A. E. Draggert, company rural service engineer at Kankakee. It uses a ¼-hp. motor with a 2-in. pulley belted to an 8-in. pulley on the output shaft of a 10:1 ratio hand tool grinder. An appropriate linkage connects the grinder handle with a rocker bar running the length of the water tank. Milk stirrers on the ends of sash cord dropped from arm on the rocker bar agitate the milk. An extra stirrer may be used to circulate the water in the cooling tank. Using Draggert's design the rocker bar makes one complete oscillation for every 40 revolutions of the motor.

Specification for the homemade milk stirrer is one of a series of data sheets being distributed by the company describing items of electrical equipment for the farm that can be built in the home workshop.

•

Trading Post Sells Three Out of Four

In the first five months following the introduction of an appliance "Trading Post" on the sales floor of its Peoria office in August 1943, 118 out of a listed total of 160 idle appliances have been put in the hands of eager users by the Central Illinois Light Co.

Success of the plan in Peoria has led the company to install similar posts at its seven other offices in the surrounding area. The increased number of trading centers and the resulting improvement in the diversity and number of idle appliances available to purchasers has led the company to expect even a higher ratio of sales to listings in the future than was established at Peoria in early months.

Each district office now relays a monthly list of appliances available, wanted and sold to headquarters, where it is coordinated with similar lists of other offices. A consolidated list for all divisions is then forwarded to each division for reference and posting.

Besides the word of mouth advertising that is given the trading post by customers visiting sales floors in the course of paying monthly bills, the company draws attention to the appliance exchange in periodic newspaper advertising with the result that the post has become a popular and eagerly consulted bulletin.

Operating record of the Peoria trading post for the first five months of its existence follows:

Month	Listed	Sold
August	18	10
September	39	23
October	30	17
November	26	12
December	47	56
Total	160	118

The Peoria trading post differs from bulletins of a similar nature in other companies in that the address and telephone number of appliance owners having units for sale are listed directly, together with the

A TOTAL of 118 appliances out of 160 listed on the "trading post" changed hands during its first five months of existence

Guaranteed TO OPERATE FOR One Year!

Now it is possible to *guarantee* a full year's lighting except for failure due to breakage . . . because the life expectancy of the new COLOVOLT Lamp is actually 10,000 hours! And replacements, when needed, can be made *instantly* . . . with standard, interchangeable 93 inch COLOVOLT Lamps. Consider what these two features contribute towards the reduction of maintenance costs . . . yes, and in the ease with which light levels can be fully maintained at all times.

With the introduction of COLOVOLT, General Luminescent has paved the way for a low voltage cold cathode "packaged unit." Accessories and fixtures for standard 93 inch COLOVOLT Lamps are now available from national manufacturers.

COLOVOLT Lamps embody many other important features . . . for example, instantaneous starting and low voltage operation . . . all detailed in our book of "Facts About COLOVOLT." Write for your free copy today!

GENERAL LUMINESCENT CORPORATION
638 SOUTH FEDERAL STREET • CHICAGO 5, ILL.

10,000 HOUR
life expectancy means low maintenance cost.

430-460 VOLT
operation eliminates special wiring, increases safety factor, reduces fire risk.

INSTANTANEOUS STARTING
. . . no starters needed, no flickering.

COLOVOLT

Packaged COLD CATHODE LOW VOLTAGE Lighting

FREE!

Send for copy of booklet giving 40 facts about COLOVOLT. Write today!

names and address data for customers seeking specific appliances.

Customers are encouraged to do their bargaining with appliance owners. In no case does the company participate in the transaction or the handling of money involved. In this way the detailed work connected with the operation of the service is kept at a minimum, being handled as a part time duty of one of the home service representatives in most offices.

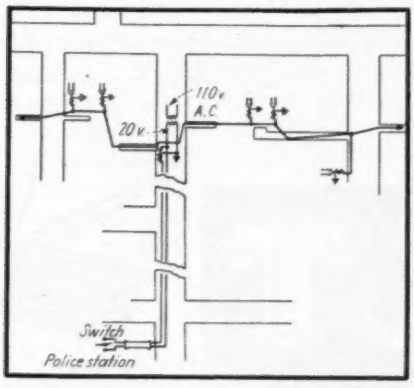
•

Dimout Control for Window Lights

By G. E. BISHOP
Electrical Supt.,
Coast Counties Gas & Electric Co., Santa Cruz, Calif.

Originally devised as a control system to extinguish quickly store window lights and signs in case of blackout, the simple control system in use in Santa Cruz, Calif., while still in operation for the original purpose, may have peacetime applications as well. As the accompanying sketch shows, it consists of a 110/20-volt step-down transformer with one leg grounded and the hot leg looped through a switch at the police station to actuate a master relay. When this relay is de-energized by opening of the switch, the various relays at the different stores drop out and extinguish the lights.

Since the secondary control circuit is only 20 volts, the control wire was run along the face of buildings. Each merchant taps the control wire and provides his own relay.



WIRING DIAGRAM of window lighting control circuit

The system has operated with 100 percent satisfaction to merchants and the utility alike and is particularly applicable to the smaller cities and towns.

•

What Equipment Do Farmers Want?

What farm equipment offers the greatest possibility for volume distribution on farms nationally?

At least a tentative answer to this question is found in the 176 replies to a questionnaire circulated among 250 utility rural service engineers, manufacturers' rural service men, agricultural engineers of colleges, under the joint sponsorship of the Farm Utilization Committee of EEI and the Rural Electrification section of the American Society of Agricultural Engineers.

A progress report on survey findings to March 23, 1944, was recently distributed at the Electric Farm Utilization Conference of EEI in Chicago. This report tabulates the replies which were received from the following groups:

Colleges	47
Utilities	109
Manufacturers	5
Others	15

The accompanying tabular summary covers the replies from 43 states. In it equipment is listed in order of importance from the standpoint of volume of distribution in the opinion of those answering the questionnaire. Table I lists items of equipment which appeared most often on questionnaires, within the first 10 mentioned.

Other equipment frequently mentioned was farm shop equipment, insect traps, special farm lighting equipment, electric churns, and dairy sterilizers.

Opinion was also sought in the survey relative to the design of present equipment; that is:

1. Is present equipment design satisfactory?
2. Should there be a slight modification in design?
3. What attention should be given to an entirely new design?

Table II is a listing from the 176 replies turned in to date and deals with the opinion expressed relative to change in design.

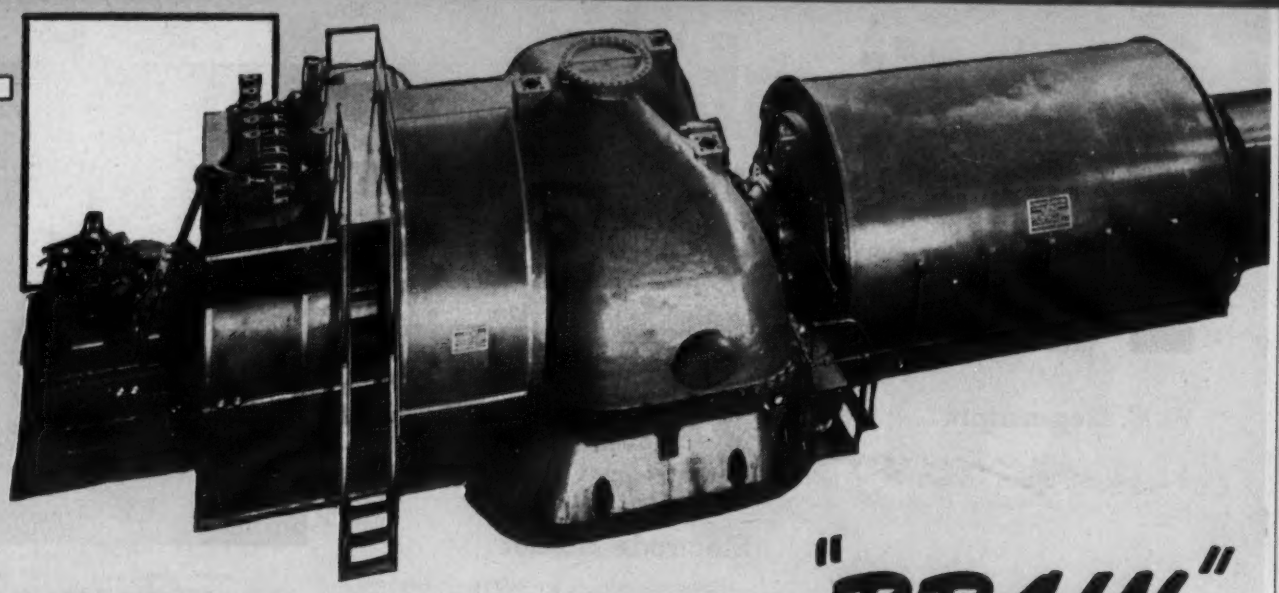
This data—according to the progress report—indicates that "opinion is very strong in favor of 'slight modification' and 'new design' of refrigeration equipment. This applies primarily to home freezer cabinets and farm storage refrigeration. Others standing high in the list needing new design include: elevators, barn cleaners, stock water heaters and feed grinders."

Table I—Ten Most Popular Farm Equipments

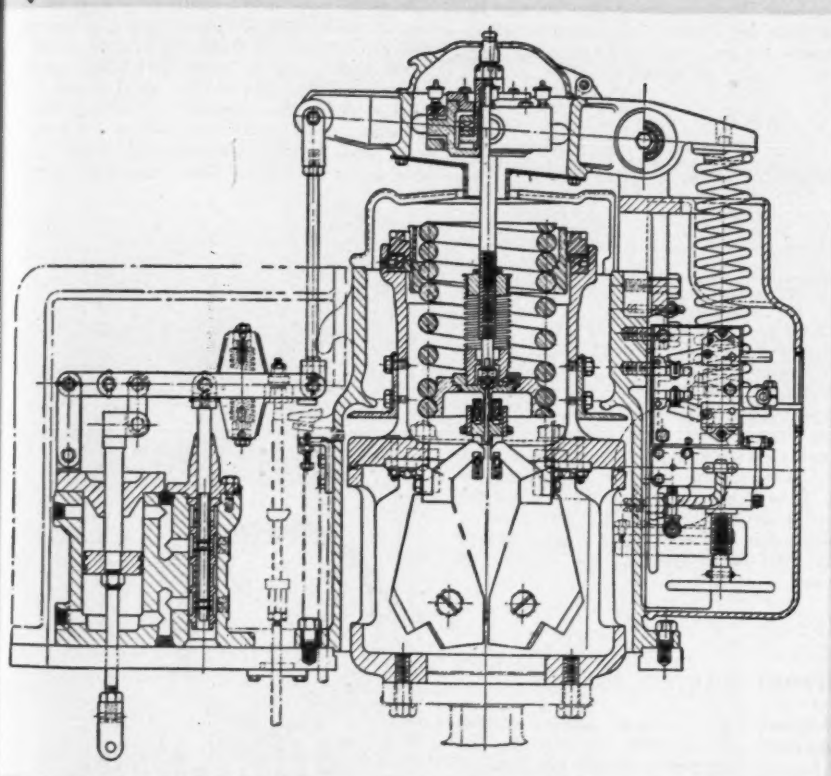
Item	Order of Preference					Total
	1st	2nd	3rd	4th	5th	
Water Systems	53	23	16	11	4	107
Refrigeration (including home freezer cabinets)	42	27	20	12	2	103
Brooders	12	14	23	18	8	75
Water Heaters	13	15	19	10	8	65
Feed Grinders	2	9	9	23	18	61
Milking Machine	7	19	17	11	5	59
Elevators	2	2	6	7	6	23
Barn Ventilators	4	8	4	2	3	21
Farm Motors	3	3	2	4	4	16
Cream Separators	1	5	2	4	4	16

Table II—What Farm Equipment Needs Redesign

Item	Needs Slight Modification	Should be New Design	Total
Refrigeration	24	24	48
Brooders	20	9	29
Feed Grinders	16	10	26
Water Heaters	16	10	26
Barn Ventilation	9	8	17
Stock Tank Heaters	5	11	16
Elevators (all types of farm)	4	12	16
Barn Cleaners	2	11	13
Milking Machine	7	5	12
Water Systems	4	3	7
Farm Motors	3	3	6
Cream Separators	2	4	6



Why that sensitive turbine "BRAIN" needs this better turbine oil



THE GOVERNOR mechanism of a steam turbine is as delicately balanced as a finely made watch. Yet the oil that lubricates this sensitive turbine part must also be able to withstand the high speeds and pressures encountered in lubricating the main and thrust bearings.

It is under these extreme operating conditions that ordinary turbine oils break down. They oxidize rapidly . . . develop rust. If the oil does not have the properties to resist oxidation and prevent rust, you have trouble on your hands.

Rust, which may either be formed in the governor or carried into it by the oil, gets into the delicate mechanism, causing it to stick. And when an oil oxidizes it may form lacquer and sludge which in turn "gums up" the governor.

These are the problems Shell Engineers licked when they perfected Shell Turbo Oil. Developed expressly for turbine use, Shell Turbo Oil has *superior oxidation stability* as well as the ability to *prevent rust.* Drain and clean your turbines...then change to Shell Turbine Oil and you'll soon see *why* it was the first of its type to be approved as meeting rigid U. S. Navy specifications.

* * *

Get the full details from your Shell man today. Write Shell Oil Company, Incorporated, 50 W. 50th St., New York 20, N.Y., or 100 Bush Street, San Francisco 6, California.

SHELL TURBO OIL

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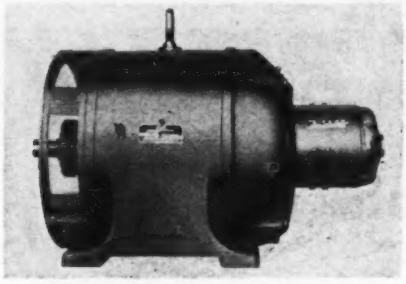
NEW EQUIPMENT

A. C. Generators

Revolving field a.c. generators have been designed for direct connection or belted drive to a gas engine. Illustration shows



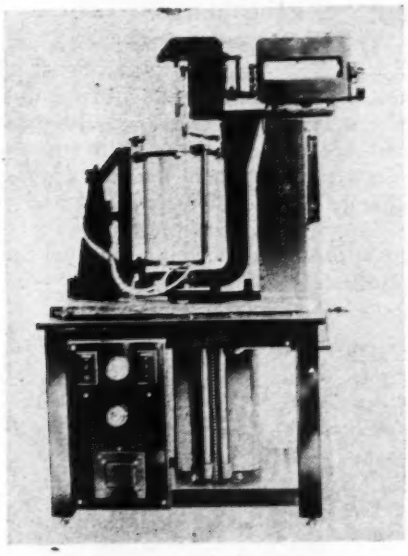
Gas-engine-driven a.c. generator: sizes 0.5 to 150 kva. **Century Electric Co.**, 1806 Pine St., St. Louis, Mo.

generator with one bearing, arranged for bolting directly to engine housing; the generator shaft is connected to the engine shaft by a coupling. Exciter with one bearing at outer end is carried by generator bearing. Exciter shaft is inserted in and keyed to the generator shaft.

•

Dilatometer

Direct-reading dilatometer records temperature-dilation changes and temperature-time changes simultaneously in ink on a rectangular chart during heating and cooling cycles of ferrous and non-ferrous metals,



Model "A-134" dilatometer: furnace for temperatures to 2,500 deg. F., accommodates samples up to 1⅝ in. dia. by 5 in. long. **The Bristol Co.**, Waterbury, Conn.

ceramics and other materials in solid forms. Split furnace can be pulled away from sample for quenching or cooling.

•

Electrode Holder

Helium-shielded, arc-welding electrode holder. **General Electric Co.**, Schenectady, N. Y.

Arc-welding electrode holder for manual operation is suitable for use with either helium or argon gas and is designed for use in the welding of light metals, such as magnesium and its alloys. Holder consists of Textolite handle, steel gas nozzle and copper electrode clamp fitted with a tool steel spring-collet. The clamp holds a tungsten or a carbon electrode until all but a ¾-in. stub is consumed, it is claimed. Button for controlling gas supply valve is on the handle, and will remain in ON or OFF position without being held. Tapered friction joint between electrode clamp assembly and handle is said to facilitate change of electrode size without using tools or making threaded connections. Various-size electrodes may be left in their respective clamps and substitution made by removing one assembly from handle, slipping on another.

•

Temperature Controls

Chronotrols: 25 models, including ten for proportioning control and others for two-position and three-position on-intermediate-off control for high- and low-temperature applications. **Wheelco Instruments Co.**, Harrison and Peoria Sts., Chicago 7, Ill.

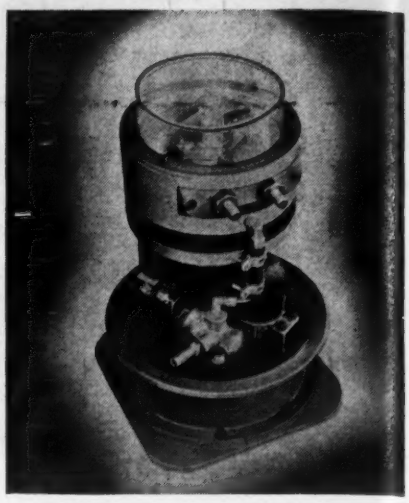
A line of electronic instruments to enforce any desired heating or cooling program employs a sensing unit. Frequency of oscillating current flowing between pick-up coils, mounted on temperature control setting index, is changed when a control flag mounted on the pointer or pen arm is moved between the coils by a temperature drop. This frequency change in the control circuit governs the output current of a vacuum tube, acting to open relay contacts which, in turn, operate fuel valves or switches.

•

Current Interruptor

Designed for high-speed, arcless current interruption of inductive d.c. circuits, the unit has contact points which are shunted

BUYING ELECTRICAL EQUIPMENT?—McGraw-Hill's *Electrical Buyers Reference* is a convenient place to look first for manufacturers' product data, names and addresses.



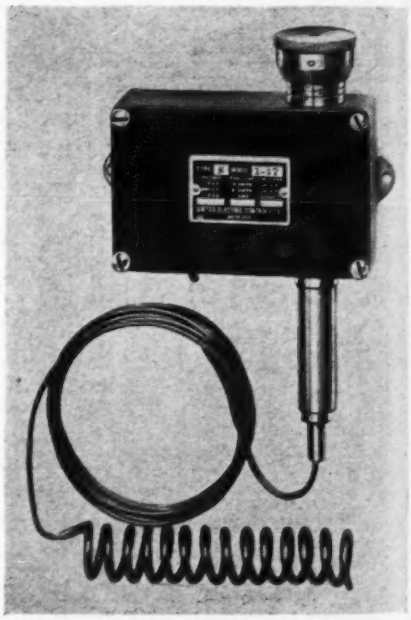
"Dynatrol" single-pole current interruptor: welder capacities up to and including 50 kw. **Sciaky Bros.**, 4915 West 67th St., Chicago 38, Ill.

by a bank of capacitors. It is operated by compressed air, consists of a three-way valve, a free piston and a contact actuating plunger, and is used on resistance welders of the electro-magnetic stored energy type.

•

Thermostat

Designed to control temperature over a wide range or any intermediate short range. The units have differentials of ½ deg. to 1 deg. F. in liquids, sub-zero testing cabinets and mechanical connection ovens, to 2 deg. F. in gravity ovens. Liquid-filled bulb and tube assembly. Obtainable in 3 types in each model; close circuit on falling temperature, open circuit on falling temperature, and double throw switch with one side normally closed, other normally open.



Type "K" thermostat: available in 5 models; temperature control ranges from —120 to 600 deg. F.; micrometer adjustment; differentials ½ to 2 deg. F.; single-pole switches, 10 amp., 125 volts or 2 amp., 600 volts. **United Electric Controls Co.**, 69 A St., Boston 27, Mass.

A Case of Identity

REQUISITES FOR LIGHTNING ARRESTERS

1. High Protective Level
2. Ability to Carry Heavy Surge Current
3. Good for Both Long and Short Wave
4. No Breakdown on Normal Current
5. Moisture Proof*
6. Operate in All Climates
7. Long Life
8. Field and Laboratory Success
9. Ability to Prevent Line Lock-out
10. Operating Characteristics Unchanged Over Long Service

The men illustrated above are three Electrical Engineers and a Purchasing Agent. These men collaborated in preparing the list of "Requisites for Lightning Arresters" shown at the left. The list was recently published and distributed by a leading Electrical Trade Paper.

* No. 5 was unanimously voted most important.

OPERATING MEN ASK FOR IT!
HUBBARD AUTOGAPS HAVE IT!

Hubbard Autogaps Have the Answers

1. Yes! Rapid operation — characteristics are fixed. Breakdown point 55% of insulation strength of equipment.
2. Excellent! In excess of 65,000 Amperes of surge current without failure.
3. Yes! Handles Long and Short Waves with equal ability.
4. No! Gap settings are above possible 60 cycle voltages.
5. Better than moisture proof. Design characteristics for Expulsion Type Arrester not affected by moisture.
6. Yes! High and low altitudes — high and low temperatures have not affected good performance.
7. Yes! Made entirely of time-tested, durable material — virtually unaffected by each operation.
8. Excellent laboratory performance confirmed by several years field experience.
9. Yes! Multiple gaps in series containing *no fusible material.*
10. Field experience proves unchanging values over long period of service. Oscillograms are available.

In other words . . . these four men might well have written a single word on their list . . . "Autogaps"

HUBBARD AND COMPANY

PITTSBURGH . . OAKLAND CALIFORNIA CHICAGO

Does a Saboteur Menace Your Power Plant?

Is heat baking out the insulation on your wiring? Is moisture raising havoc with your motors? Or could it be that corrosive vapors are causing frequent power failures? The work of any one or all three of these sabotage agents will ruin ordinary power cables. Today that's serious because a break in your power circuits may mean a delay in some plants' war production.

The next time you make an inspection trip around your power plant, check the torrid zones where these saboteurs may be busy at their destructive work. Then rewire with Deltabeston Power Cable. You'll find there's no better protection for general wiring in power plants where severe operating conditions exist.

Deltabeston Power Cables Types AVA and AVL are also ideal in steel mills, boiler rooms and in other places where constant high temperatures prevail. Deltabeston is insulated with asbestos purified by an exclusive process which gives it great heat resistance. The purified asbestos is "felted" to the flexible copper by a patented method which produces an extremely tight bond. The asbestos is then impregnated with a special compound to make it highly resistant to moisture and corrosive vapors.

For additional information write to Section Y441-9, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn. G-E Deltabeston wires are distributed nationally by Graybar Electric Co., G-E Supply Corp. and other G-E Merchandise Distributors.

BUY WAR BONDS

GENERAL ELECTRIC

TECHNICAL LITERATURE

INFRARED HEATING—Many infrared installations of less than 25-kw. connected load are doing yeoman service for industrials. Schematic diagrams of processes, case histories, and photographic illustrations explain many applications, presented in "Good Things Come In Small Packages," publication No. 144, issued by the Fostoria Pressed Steel Corp., Fostoria, Ohio.

COMPRESSED AIR—Tables and data on discharge of compressed air from ⅛-in. to 6-in. openings with line pressures ranging from 10 to 125 psi.; average cfm., at 90 lb. gage pressure, for operation of pneumatic tools; and charts to determine the size of Aridifier for purging air and gas lines of moisture, oil, dirt, rust and fine scale are contained in Bulletin No. 543A, "The Aridifier," available from Logan Engineering Co., 4907 Lawrence Ave., Chicago 30, Ill.

THERMOSTATIC BI-METALS—Principle of bi-metal, tables and formulas on the deflection and power of the various types in strip and coil, also data on thicknesses and sizes, are contained in Technical Bulletin No. 155, "Calliflex Bi-Metals," issued by Callite Tungsten Corp., 540 39th St., Union City, N. J.

CONDENSATE—How condensate is sampled continuously by means of a conductivity cell, and its purity indicated and recorded automatically by means of a recording instrument is explained and illustrated in a 23-page publication, "Micromax Condensate-Purity Instruments for the Steam Plant," Catalog N-95-163, issued by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

"POWER CENTERS" is a 25-page booklet containing a guide to the selection and specification of indoor and outdoor transformer installations, including co-ordinated disconnect and protective equipment. Standard arrangements of unit substations are suggested to fit the various types of distribution systems. Booklet B-3224 may be obtained from Department 7-N-20, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

"GUIDE TO WELDABILITY OF STEELS" proposes systems of determining the effect of welding procedure upon the ductility of the heated zone adjacent to the weld in plain carbon and alloy steels. Tables and charts. 89 pages. Price $1. Welding Research Council, 29 West 39th St., New York 18, N. Y.

"WHITE METALLING"—This book is intended to assist the attainment of successful technique and reliable results and to provide methods of relining white metal bearings. Some of the subjects covered are alloys in use, modern lining procedure, cleaning and tinning procedure, jigs, lining special bearings, white metal stuffing box rings, fusible plugs for steam boilers. Illustrated. Price 2 shillings. Emmott & Co. Ltd., 78 Palatine Road, Manchester 20, England.

COMBUSTION CONTROL—Embodied in a 37-page edition is an explanation of how the system operates, an outline of five types of control, and other items of interest to users. The publication "Metermax Combustion Control for Boiler Furnaces," Catalogue N-01M-163, is well illustrated and can be obtained from Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

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over those "long, long, trails"

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★ The job of transporting cable reels and poles has been reduced to an easy method by utilities employing Highway Trailers.

For example, the pole trailer eliminates the necessity of a special truck with a bolster on the truck bed and permits the trailer with its load of poles to be hauled by trucks equipped with any type of line construction bodies. Loading a cable reel is quickly accomplished by tipping trailer back until saddles engage with spindle inserted through the center of the reel. The tongue is then pulled down and coupled to the truck.

In developing your post-war plans give thought to the haulage question for here is opportunity for you to save on special truck costs, on transportation time, and on loading and unloading time and effort. We will gladly send you a catalog that pictures and describes the various types of Highway Trailers.

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NEWS ABOUT PEOPLE

R. L. Hayden to Direct Coast Counties Sales

R. L. Hayden, manager of the Contra Costa division of Coast Counties Gas & Electric Co., California, has been appointed sales manager of

all electric and gas sales activities. He will take over duties which have been carried for the past year and a half by H. W. Edmund, who in addition to his duties as vice-president and general manager, had directed sales.

Mr. Hayden joined Coast Counties Gas & Electric Co. 14 years ago and was manager of the Imperial District before becoming manager of the Contra Coasta division, an industrial center of the San Francisco Bay area. He has been active in sales and commercial sections of the Pacific Coast Electrical Association.

•

Completes Half-Century of Service; Retires

Henry J. Gille, who for the past 12 years has been manager of industrial and agricultural development for Puget Sound Power & Light Co. in Seattle, Wash., retired April 1 after 54 years of service in the electrical industry, 31 years of which he spent with Puget Power.

A native of St. Paul, Minn., Mr. Gille began his career in 1890 when electricity was still a budding industry—with the Acme Electric Co. In 1898 he became general superintendent of the Edison Electric Light & Power Co. in St. Paul. From 1907 to 1913 he was associated with the Minneapolis General Electric Co.

Moving to the power fields of the Pacific Northwest, Mr. Gille joined Puget Power in 1913 as general sales manager, from where he advanced to the position he held prior to his retirement.

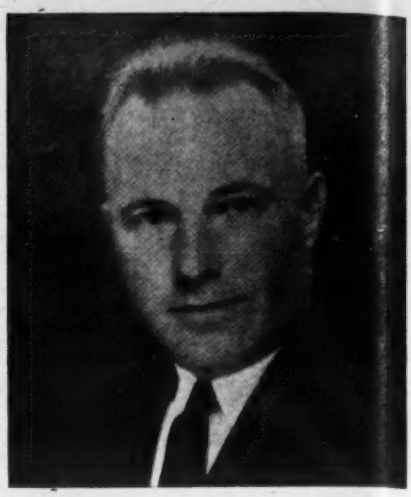
A prominent figure in the development of Washington state resources, as well as electrical improvements, Mr. Gille has been president of the Manufacturers' Association of Washington, Northwest Electric Light and Power Association, West Coast Mineral Association and Associated Chambers of Commerce of Washington. He is a life member of the American Institute of Electrical Engineers.

•

J. P. McKearin Retires; J. W. Bennett Takes Over

James P. McKearin, chief engineer of the Western Massachusetts Electric Co., Springfield, has retired from that position and has been succeeded by John W. Bennett. Mr. McKearin left the Boston office of General Electric in 1917, where he was assistant district engineer, to become electrical engineer of the United

J. P. McKearin



J. W. Bennett

Electric Light Co., Springfield, being made electrical engineer for the constituent companies in the Western Massachusetts group in 1927 and chief engineer in 1936. He was responsible for the design of the Cobble Mountain hydroelectric station built in connection with the Springfield water supply system and leased by the Western Massachusetts company. Many major improvements in the 66 and 115-kv. transmission lines and substations in the middle Connecticut Valley, network installations at Pittsfield and Springfield and carrier current facilities in the territory were made under Mr. McKearin's direction. He is a fellow of the A.I.E.E., and has long been prominent in the Engineering Society of Western Massachusetts.

John W. Bennett, who has become chief engineer of the Western Massachusetts Electric Co., was educated at the University of Minnesota. He was engaged in utility engineering work in New Jersey, previous to joining the Western Massachusetts organization in 1930 as distribution engineer, later becoming assistant chief engineer, with headquarters at Springfield. He is a past-chairman of the Springfield section of A.I.E.E., and past-president Engineering Society of Western Massachusetts.

•

► S. B. Irelan, who has been associated with various subsidiaries of the Cities Service system for 35 years, has been elected as president and a director of the Cities Service Gas Co., succeeding H. R. Straight, resigned. For the past several years Mr. Irelan has been associated with the Cities Service Power & Light Co. in New York in the capacity of vice-president in charge of property valuation and refinancing of subsidiary public utilities. His career with the Cities Service organization has brought him to almost every section of the

A new money-saving serving tool

Patents Pending

To make "dead ends" in bethanized strand and Ruralductor

Here's money-saving news for the power and telephone industries. The news is the chromium-plated gadget, shown above, that looks rather like a towel rack trying to be a clothes hook. This is Bethlehem's new "serving tool," designed to help linemen make quick, easy "serves" on dead ends of bethanized strand and Ruralductor, on telephone and power lines.

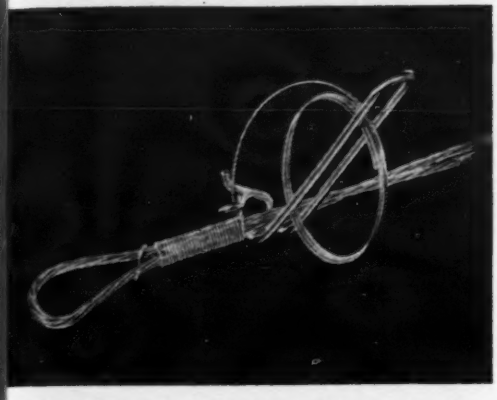
The "dead end coil" method, performed with this tool, does the work of clamps, or replaces the old familiar "breakdown serve," which, when made with pliers, invites corrosion by damaging zinc coatings. It provides for future take-up since the parent strand is not destroyed, as in "breakdown serves," and the dead end wrapping can be removed with the same tool.

Note the illustration of the tool, in process of wrapping 11-gauge bethanized dead end wire around a looped end of strand. And note the photograph of finished serves—*which tests have shown to have holding power above the useful strength of the strand.*

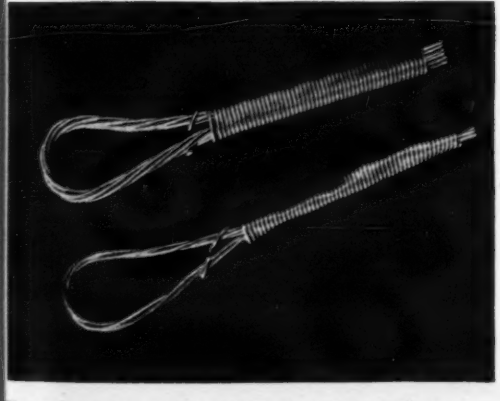
Any lineman can make these serves. The dead end wire is engaged between the two "fingers" projecting from the tool, which hold it under effective, steady tension while the tool is rotated. Fifty quick turns—and the job is done.

The action of the smooth, hard "fingers" of the tool displaces a minimum amount of the ductile, vise-tight zinc coating of bethanized wire or strand. However, the tool is recommended for use only on bethanized strand, as the holding power of the dead end is not always reliable with other types of coating.

If you are already using bethanized strand, you will of course find plenty of uses for the Bethlehem serving tool. If you haven't yet decided on bethanized—we suggest you fully consider the savings it will make for you, in combination with the tool. For full information, see the nearest Bethlehem representative, or write direct to Bethlehem Steel Company, Bethlehem, Pa.



The Bethlehem Serving Tool, in position, in a partly-completed serve.



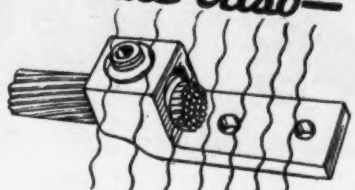
Typical serves on 3- and 7-wire strand. Note the tight, uniform wrapping of wire.

BETHLEHEM STEEL

1: Not Only—

Solderless;

2: But Also—



Vibration-Proof;

3: As Well As—

Easy to Install.

A Twist of a Wrench and They Will Hold for Keeps.

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SOLDERLESS CABLE TERMINALS

EV-R-ONS Are Extra-Machined So That Each Face Provides TWO Contact Surfaces. These Often Make It Possible to Install These Lugs in Compact Areas Where the Clearances Are Insufficient for Conventional Mounting. More Costly Alloys Are Used. Class 2 Threads Make Stripping Practically Impossible.

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"You're Well Connected with SHELDON"

Sales Agents: We now have some excellent open territories.

country—Denver, Colo.; Fremont, Neb.; Bartlesville, Okla.; Sedalia, Mo.; Montgomery, Ala.; St. Joseph, Mo.; Kansas City and New York. He has participated actively in the affairs of representative electrical associations, having served as president of the southeastern division of the old National Electric Light Association when located in the South and as head of the Middle West division when he was located in that section of the country. Mr. Irelan will assume immediately his new duties in the management of the expanding activities of Cities Service Gas Co.

•

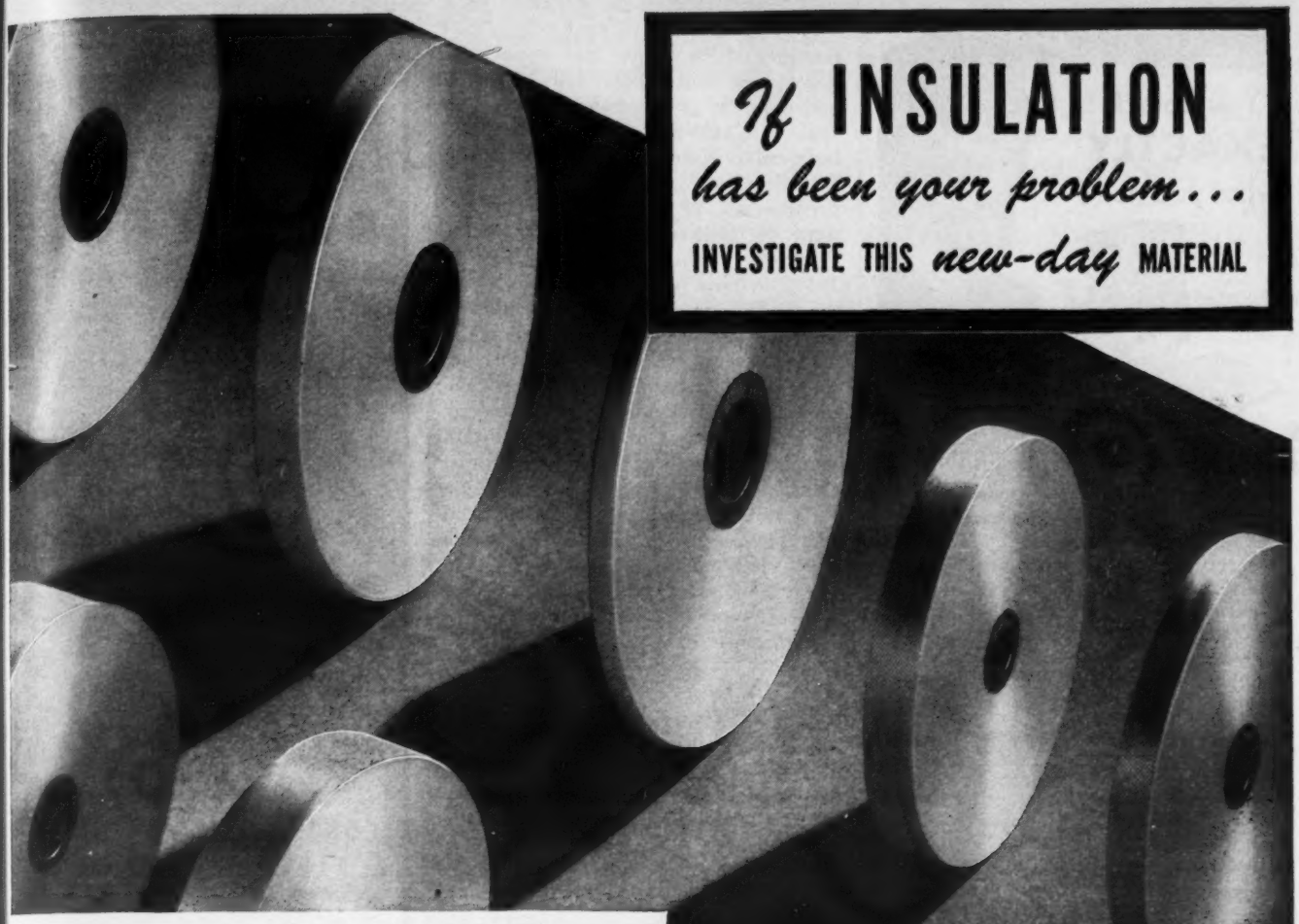
Colonial Lighting Names Lyons Sales Manager

Lester W. Lyons has been appointed sales manager of the Colonial Lighting Division of the Colonial Neon Co., Inc., North Bergen, N. J.

Mr. Lyons is well known in the lighting industry. He organized and directed the illuminating engineering bureau for the Brooklyn Edison Co. from 1923–28. Early in 1929 he became affiliated with Silvray Lighting, Inc. as a member of the engineering staff and was promoted to sales manager in 1932. He held this position until late in 1942, when he requested a leave of absence to join the radio division of the Western Electric Co. for the purpose of actively participating in war work.

•

▶ JOHN AVERY has been appointed manager of the Allis-Chalmers blower and compressor department to succeed G. L. Kollberg, who is retiring after 47 years of service with Allis-Chalmers. Mr. Kollberg will continue with the company as consultant and adviser on the engineering matters with which he has been intimately associated for so long. Mr. Avery has been assistant



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● Kappa Cellulose Acetate Rayon Tape offers so many important points of superiority over previously specified materials. It may easily lead to substantially improved performance in your product...while at the same time resulting in production savings.

For example, a well-known maker of refrigeration units found that use of Kappa Tapes overcame a serious problem of rapid deterioration where motor insulation came in contact with refrigerant gases. Standard low cost Kappa Tape will take the place of costly hard-to-get special materials previously necessary in this application.

Again, where space is a factor in small motors and coils, etc., the fact that Kappa Tapes impregnate completely and uniformly with fewer varnish dips and less varnish build-up is a distinct advantage . . . especially since there is usually a gain rather than a loss in dielectric strength.

Let us send you a copy of the Kappa Technical Bulletin giving detailed results of electrical and physical tests, also long length samples in the widths and mil thicknesses you use.

NEW 10 MIL TAPE NOW AVAILABLE!!!

with entirely new type of construction resulting in 52% greater tensile strength. Samples on request.

Write to The Wm. E. Wright & Sons Co., Industrial Textile Division, Box 1000, West Warren, Mass.

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Trade Mark Reg. U.S. Pat. Off.

CELLULOSE-ACETATE RAYON

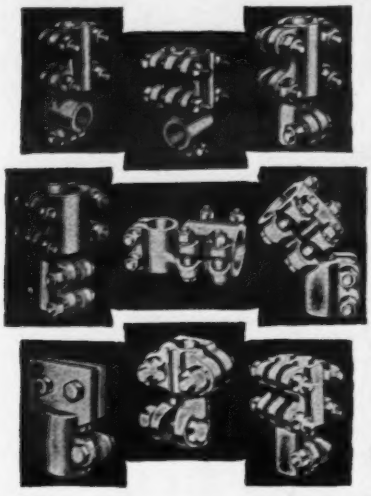
COIL-WINDING TAPES

The Wright tape for every winding.. KAPPA

"You select
EXACTLY
what you need—

—from the COMPLETE line"

Stud Connectors and Solderless Terminal Adapters for distribution and power transformers . . . for connecting to cable, pipe or bus bar . . . in line or at any angle. Connectors with reversible clamping caps take two different ranges of cable sizes. Furnished for any number of conductors. A few of Penn-Union's many types:



Also . . . the most complete line of Service Connectors, Cable Taps, Tees . . . Straight and Parallel Connectors . . . Bus Supports, Spacers , . . Grounding Clamps, Terminal Lugs, etc. etc.

Penn-Union conductor fittings are the first choice of leading utilities, industrials, electrical manufacturers and contractors—because they have found that *"Penn-Union" on a fitting is their best guarantee of Dependability.* Write for Catalog.

PENN-UNION ELECTRIC CORPORATION
ERIE, PA. *Sold by Leading Jobbers*

PENN-UNION
Conductor Fittings

manager of the blower and compressor department since 1935 and has been active in the compressor field for 20 years. A native of Sweden, Mr. Kollberg entered the employ of the Fraser & Chalmers company, an Allis-Chalmers predecessor, in 1897 in Chicago and went to Milwaukee when the Allis-Chalmers company was formed. In 1931 he was appointed manager of the newly formed blower and compressor department, following which he made several trips to Switzerland, while conducting Allis-Chalmers relations with the Brown-Boveri company in the compressor field. An important part of Mr. Kollberg's activity in Switzerland was for the purpose of studying early developments in the use of axial compressors in the gas turbine units which have since become so vital to the production of high octane gasoline in the Houdry process and which show such promise as a power source of the future.

▶ RAY C. FAUGHT, long associated with the General Electric Co.'s Baltimore office as a sales engineer, has retired after more than 43 years with the company. Following graduation from the Massachusetts Institute of Technology in 1894, Mr. Faught entered the employ of General Electric as test man at West Lynn and in 1900 was transferred to the Philadelphia office as specialist on arc lamp sales. In 1902 he went to Richmond, Va., on general supply sales and a year later was transferred to the Baltimore office. In charge of the Washington office during World War I, Mr. Faught returned, in 1919, to the Baltimore office, taking the position which he held until his retirement. He has taken an active part in the Maryland section of the American Institute of Electrical Engineers and the Engineers Club of Baltimore, serving on the executive committee and other committees of both societies.

▶ CLARENCE F. JENSKY has been appointed special representative of the Joshua Hendy Iron Works on turbine design, construction and manufacturing and will make his headquarters at their Washington, D. C., office. Mr. Jensky has been with the Hendy organization at the Sunnyvale, Calif., plant for the past nine months. Well known in the steam turbine field, he has been a leading figure in Hendy turbine development and design.

▶ DR. HARVEY C. RENTSCHLER, director of research of the lamp division of the Westinghouse Electric & Manufacturing Co., Bloomfield, N. J., was made the recipient of the Frank P. Brown Medal by the Franklin Institute on April 19. The institute made eleven other awards in science after a

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DIELECTRIC CONSTANT 3.57
DILECTENE
A CONTINENTAL-DIAMOND ENGINEERED U-H-F INSULATING PLASTIC

STABLE UNDER
- *High Humidity*
- *Temperature Extremes*
- *Mechanical Stress*
- *Chemical Conditions*

READILY MACHINED
For complete technical data, send for Bulletin DN

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 15 DC DELAWARE

ALL the strength and durability inherent in steel are combined—with definite economies—in *Crapo* Galvanized Steel Strand. Heavy, ductile, tightly-bonded zinc coatings, applied by the famous *Crapo* Galvanizing Process, provide lasting protection against corrosion.

Ask the distributor of *Crapo* Galvanized Products near you or write direct for further information!

INDIANA STEEL & WIRE CO.
MUNCIE, INDIANA

PROMPT DELIVERY

of B. F. Goodrich Anode Electricians' Gloves can be made

★

Adequate new stocks end need for dangerous patching

For almost two years the U. S. Government received the entire output of B. F. Goodrich Anode electricians' gloves. During that period users, who would never before have considered such an expedient, were forced to resort to patching to keep gloves in service. But patching is conceded to be unsafe practice. Extreme care must be used. And sooner or later the limit for patching is reached. Gloves become bulky, uncomfortable, hard to use — and so increase danger of accidents.

That situation need exist no longer.

During recent months government requirements have eased and B. F. Goodrich has been able to accumulate adequate stocks of Anode electricians' gloves — the kind made from pure natural rubber latex; the kind made by the Anode process which requires only *one* dipping of the forms — instead of the repeated dippings required with ordinary methods that build up stiffening layers of rubber compound; the kind that are more comfortable because of the scientifically designed *curved* fingers and the flexibility made possible by the *single* dipping.

The B. F. Goodrich distributor near you will be glad to show you these gloves and tell you more about them. He'll see that you get prompt delivery of your requirements. Call him, or write *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich
Electricians' Gloves

RELIABLE CAN HELP YOU

SAVE TIME

in speeding the war program by using Reliable Straightline splices on new construction and on maintenance.

SAVE COPPER

by using these perfect joint making units over and over again.

Positive
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dinner given for the medalists and several hundred guests. Dr. William D. Coolidge, vice-president and director of research of the General Electric Co., shared the highest award bestowed by the Institute (the Franklin Medal) with Dr. Peter Kapitza, director of the Institute for Physical Problems of the Academy of Sciences, U.S.S.R. (ELECTRICAL WORLD, April 8, page 16).

► WILLEM F. WESTENDORP, of the X-ray section of the General Electric research laboratory in Schenectady, received the John Price Wetherill Medal from the Franklin Institute for his development of the resonance transformer which made possible the million-volt X-ray apparatus now in use by many war industries. The silver medal was conferred upon Mr. Westendorp, the Institute's citation said "in consideration of his development of a successful high-voltage, low-frequency resonance transformer of relatively small size and light weight, which is shock-proof, efficient in operation and particularly suitable for uses in high-voltage portable X-ray units." A native of Amsterdam, Holland, Mr. Westendorp came to the United States immediately following his graduation from the University of Delft in 1928 and entered the employ of the General Electric Co. He has been with the research laboratory since 1930 and has been granted 28 patents.

OBITUARY

► GEORGE W. HUBLEY, well known engineer of Louisville, Ky., died on April 8 in that city at the age of 74. Years ago Mr. Hubley went to Louisville on an assignment from Westinghouse as a trouble shooter in repair work at the old Louisville Lighting Co. plant. He later was made chief engineer and superintendent of the company, which subsequently became the Louisville Gas & Electric Co. He remained with that utility until 1915 when he was appointed general manager and chief engineer of the Merchants Heat & Light Co. of Indianapolis. In 1918 he became administrative engineer and chief of conservation of the U. S. Fuel Administration in Kentucky, was consulting engineer of the State Board of Charities and Corrections from 1920 to 1924, and was engineer for the Louisville Public Utilities Bureau from 1923 to 1935. Mr. Hubley had been retired from business for the past two years. He was a fellow of the American Institute of Electrical Engineers.

► M. E. THOMPSON, electrical industry pioneer, inventor, and father of the compensated generator, died at his home in Ridgway, Pa., April 5 at the

FLOORS that make LIGHT MORE EFFECTIVE

Light-Reflecting Floors made with Atlas White cement make seeing easier.

Light-colored floors, since they are close to work areas, may have even greater influence on the effectiveness of lighting systems than do light-colored walls and ceilings.

Dark floors absorb light and waste it. But light-reflecting floors made with Atlas White cement instead of gray cement, conserve light and reflect it back where it is needed. They reduce shadows and dark areas, and distribute light evenly throughout the whole working area. They reduce the contrast in brightness between the background and the task and thus make seeing easier and quicker.

Data on actual installations, lighting tests, costs and maintenance experience are found in the booklet "Light from Floors." For your copy write to: Atlas White Bureau, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

HOW ABOUT MAINTENANCE?

Experience shows white-cement floors are easy to clean, easy to keep clean, and retain their reflection advantage. Maintenance is simple—frequent sweeping, occasional damp mopping, periodic scrubbing.

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ATLAS WHITE CEMENT
For Light-Reflecting Floors

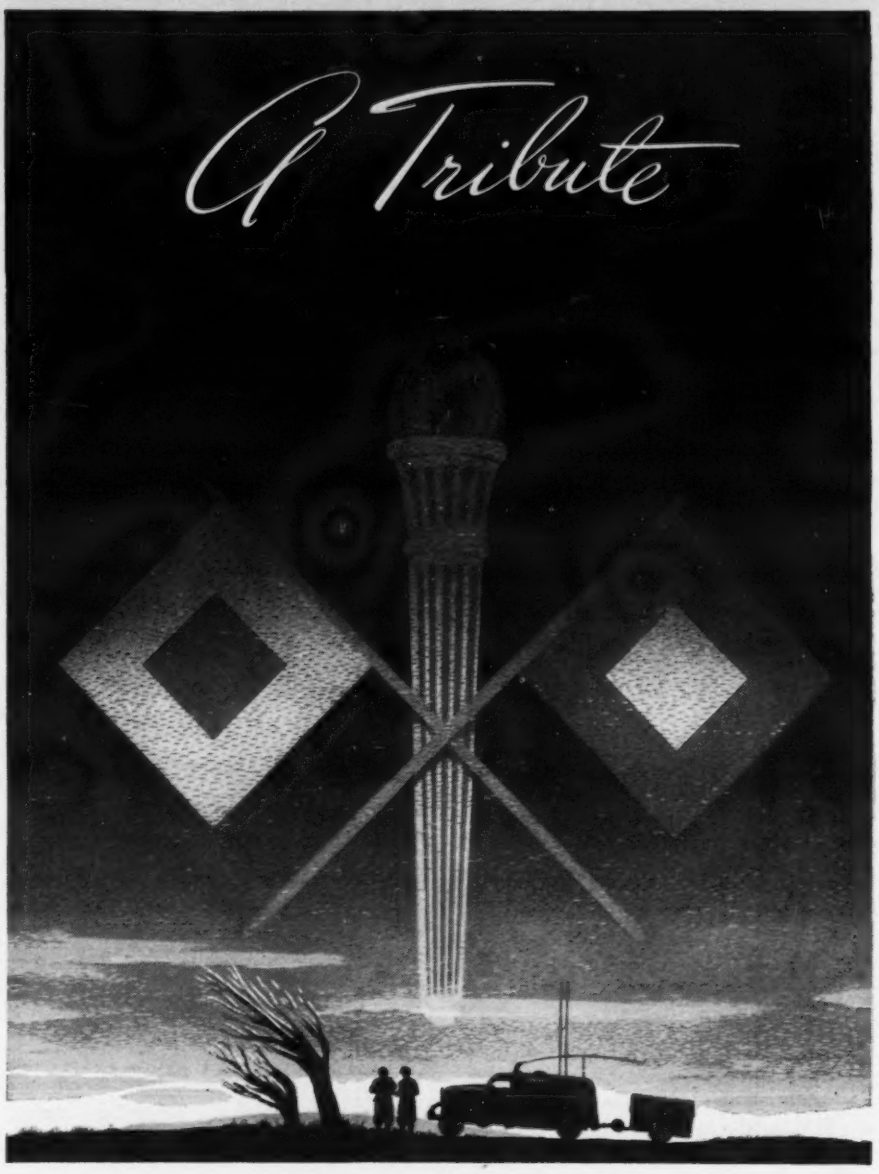
age of 80. Oldest employee on the active list of the Ridgway division, Elliott Co., Mr. Thompson was employed as consulting engineer for the Elliott Co. at the time of his death. He had previously been chief engineer of the Ridgway plant. As a result of post-graduate work with Dr. Harris J. Ryan at Cornell and later at Leland-Stanford University, Mr. Thompson designed in 1893, the 10-kw., 110-volt, six-pole, belted generator now displayed in the Edison Institute at Dearborn, Mich. He had to his credit the early invention of an alternating-current watt-hour meter of the motor type and made many contributions to the design of steam engines and other power plant equipment. As early as World War I, he was a pioneer in the development of electrical propulsion equipment for submarines of the U. S. Navy.

▶ FRANCIS S. VIELE, president of the Arizona Power Co., at Prescott, from its formation in 1907 until 1927, died recently in Los Angeles, Calif. Mr. Viele was a native of New York and was affiliated with several electric power companies in the East prior to moving to Arizona. He was 75 years old.

▶ JOHN A. MCKAY, manager of the Dominion Power & Transmission Co., at Hamilton, Ont., Canada, died on April 4 at his residence in that city after an illness of five weeks. Mr. McKay was a lifelong resident of the city.

▶ ROBERT T. BATTLE, an electrical engineer and vice-president of Filament Tube, Inc., New York, died at his home in Queens, New York, after a long illness. He was 56 years of age. A graduate of Stevens Institute of Technology, Mr. Battle had been president of R. T. Battle, Inc., electrical engineers, and at one time was in charge of the street lighting department of the New York Edison Co. While president of R. T. Battle, Inc., Mr. Battle directed the installation of lighting equipment for several buildings at the New York World's Fair. For several years, as secretary of the Master Sign Makers Association, he fought various legislative movements which seemed to him likely to result in unfair restriction of electric signs.

▶ THOMAS L. BEAUCHAMP, district manager of the Alabama Power Co. at Tuscaloosa for the past 20 years, died in that city on March 24 after a long illness. A native of Linwood, Mr. Beauchamp became associated with the power company in Decatur and went to Tuscaloosa as district manager in 1923. He held the position until last February when he relinquished his active duties, remaining in an advisory capacity.



to the members of the Signal Corps, United States Army, for their great achievements in the field of military communications. On every front, from the development laboratory to the most remote outpost, they are doing their job superbly well. . . . Hallicrafters employees are proud of the part they are privileged to take in the design and production of radio equipment for the Signal Corps.

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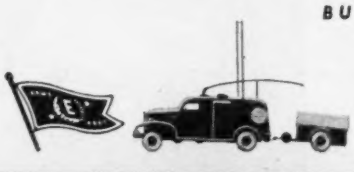


THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

hallicrafters RADIO

MANUFACTURING-MARKETS

G.E. Shipments Rise; Orders Decrease

General Electric Co.'s profit available for dividends for the first three months this year amounted to $10,384,405, compared with $10,442,576 for the same period last year, or 36 cents a share of common stock in each period, President Gerard Swope announced last week at the annual meeting of the company's shareholders. These amounts were after provision of $61,000,000 and $66,000,000 respectively, for federal taxes on income and for post-war adjustments and contingencies, a decrease of 8 percent.

Net sales billed (representing shipments) during the first quarter of this year amounted to $354,524,206 compared with $277,872,103 for the same period a year ago, an increase of 28 percent. Mr. Swope revealed that new orders dropped to $391,901,000 in this year's quarter from $422,047,000 a year ago. Commenting on the drop, Mr. Swope said it was a continuance of the decline which started last year.

During the last four years, Mr. Swope reported, General Electric has spent $116,000,000 in new plants and equipment in its expansion program to meet the demands for war materials. In addition, he said, the company is operating for the Government new plants costing $153,000,000.

•

May Take Over Navy Plant

Blaw-Knox Co. has been requested by the Navy to assume the management, under lease, of the York, Pa., ordnance plant which was taken over by the Navy from the York Safe & Lock Co. last January. W. P. Witherow, president of Blaw-Knox, said if his company assumes the lease, steps will be taken to increase production rapidly. Edwin R. Broden has been appointed chief representative of Blaw-Knox at York.

•

Report Orders Up 7%

Consolidated orders received by the Electric Storage Battery Co. in the first three months of this year amounted to $17,931,000, or 7 percent ahead of the similar period of 1943 and shipments were $19,384,000, or 8 percent ahead, R. C. Norberg, president, told stockholders at their meeting held last week at Camden, N. J. Unfilled orders on April 1, he said, amounted to $42,040,000, against $29,300,000 on April 1, 1943.

•

Hendy Diesel Units Put in Production

Green light for the immediate production of a large number of new type Diesel-generating plants has been given the Joshua Hendy Iron Works by the Maritime Commission according to an announcement by Charles E. Moore, president of the Company. The units are scheduled off the production line at the rate of twenty-two per month by the end of the year.

To develop 250 kw. each, these plants consist of Series 50 Hendy Diesel engines and Crocker-Wheeler direct-current generators, mounted on bed-plates. These units are for use on the AV-1 type of Maritime Commission ships, and will provide the electric current for general ship-board services.

In addition to the Hendy Diesel engines and Crocker-Wheeler generators ordered by the Maritime Commission, the Pomona Pump Division of the company has also been awarded substantial contracts for a wide variety of pumps to be installed on the AV-1 class of vessels.

•

Predicts Prompt Output of "Resumption" Models

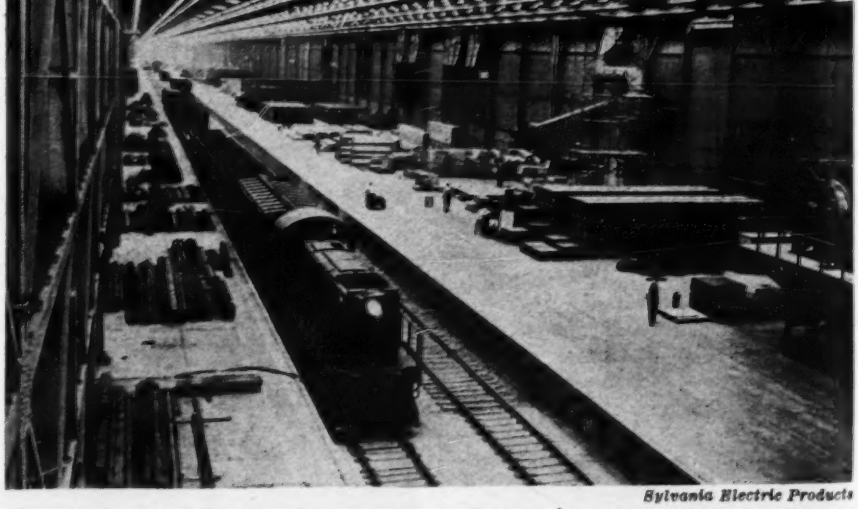
Barring a raw material bottleneck, "resumption" models of electric appliances will start to roll off the Westinghouse Electric & Manufacturing Co. assembly lines within a few months after the Government authorizes production, the company has announced.

"This forecast is necessarily conditional upon the speedy reconversion to peacetime production of our supplies of raw materials," it was stated. "In order to fill a crying need for electric appliances which wartime restrictions have prevented civilians from buying, as soon as we are permitted we intend to get into production fast on essentially those appliances sold before the war."

•

Army-Navy "E" Awards

Recent awards to plants of Combustion Engineering Co., Inc., include the Maritime Commission "M" pennant to the Heine Boiler Division, St. Louis; a



Sylvania Electric Products

NEW BOMBER PLANT LIGHTING—One of the world's largest and most modern bomber factories, operated by Bell Aircraft, at Marietta, Ga., is lighted by 72,000 fluorescent 100-watt lamps in 2-lamp fixtures. This picture shows the long receiving bay where materials are unloaded and inspected and from there moved into the production area.

PERMANENT MAGNETS MAY DO IT BETTER

Fighting Words Flash through!

RUMBLING over the treacherous roads in Italy and lunging ashore on Jap island-fortresses, this "rolling radio station" of the U. S. Signal Corps has won high praise for its splendid performance in the battle of communications.

Built by the Hallicrafters Co., and designated "SCR-299", it also illustrates a number of the constantly growing uses for which *permanent magnets* are employed today. In the 299's loud speakers, headsets, microphones, telephones, instruments and magnetos, permanent magnets are extremely vital parts.

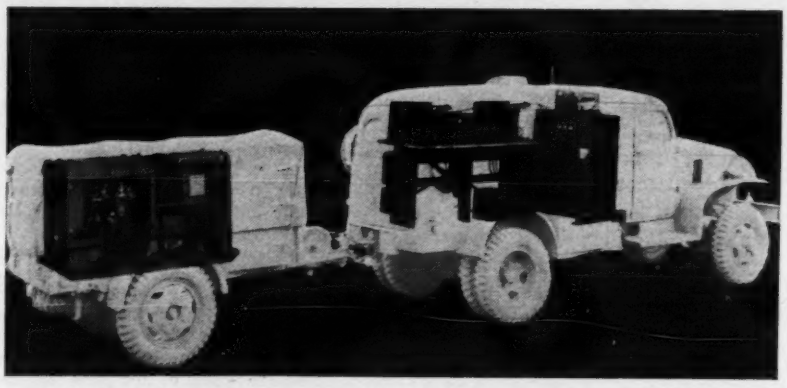
In many other types of electrical and electronic equipment for land, sea and air warfare, permanent magnets perform equally important functions. And because of our 34 years of specialization in this field, our organization has played a leading role in designing and manufacturing permanent magnets for numerous applications.

This unusual experience should prove valuable to you in solving your engineering problems . . . and our engineers will be pleased to consult with you. Write us, on your letterhead, for the address of our office nearest you and a copy of our "Permanent Magnet Manual".

★

Help Win the War in 44— Buy War Bonds!

PHOTO COURTESY U. S. ARMY SIGNAL CORPS



The "SCR-299" is mounted in various types of vehicles and is also used, dismounted, as a fixed radio station.

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INDIANA STEEL PRODUCTS
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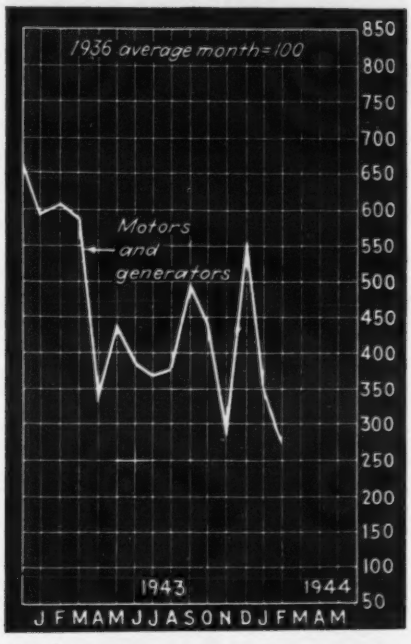
third star for the "M" pennant awarded in 1942 to the company's Hedges-Walsh-Weidner Division, Chattanooga; and an Army-Navy "E" to the company's assembly plant at Savannah, Ga.

Fargo Mfg. Co., Poughkeepsie, N. Y., received the Army-Navy "E" at ceremonies held last week in Poughkeepsie.

•

Generators Orders Decrease 24%

The index of new orders for motors and generators, compiled by the National Electrical Manufacturers Associa-



NEMA INDEX, value of orders received

tion, continued in February the downward trend which occurred in January when it declined to 353 from 554 in December, 1943. The drop in February was to the 269 point, a decrease of 24 percent from January.

Adjustment for cancellations reported up to Dec. 31, 1943, is included in the 1943 indexes. No adjustment has been made for renegotiation.

Single phase, integral hp. motors have been added to the series beginning with the month of January, 1944.

•

Gets New Quarters in N. Y.

Dugas Engineering Corp., a subsidiary of Ansul Chemical Co., Marinette, Wis., will occupy new office quarters in New York about May 1. The company will share space with Ansul in the Lincoln Building at 60 East 42nd Street. Glen Stratton will be in charge of Dugas and T. R. Kearney will represent Ansul.

Field Reports on Business

Production records in the industrial field are being maintained at astonishingly high levels. A depletion of utility inventories and preparation for summer construction have brought about an upturn in utility orders, particularly for distribution equipment. Retail trade has recovered from the post-Eastern slump

CHICAGO

An upturn in utility orders, particularly for distribution equipment, has been quite noticeable in this area for the past few months. Manufacturers generally attribute it to a depletion of utility inventories and preparation for summer construction.

One nationally known supplier of transformers, fuses, cutouts and lightning arrestors in this area, reports orders for the first three months of this year up 90 percent over the same quarter of 1943. Orders during the first three weeks of April were 15 percent above the average of the first three months, it was reported.

Transformer manufacturers report order backlogs on distribution transformers ranging up to 20 months on present production rates. A typical manufacturer of distribution transformers in the greater Chicago area reports more transformer orders received during the first three months of 1944 than in the first eight months of 1943.

In general, backlogs of utility orders for transformers and lines specialties have gone up precipitously during the first quarter due to a combination of factors. Utility stocks are low; companies are buying for summer construction; manufacturers have been unable to make deliveries because of material and manpower shortages and more significantly because of preoccupation with war business particularly in the radio and radar fields. In nearby Chicago cities the manpower situation is severe among electrical manufacturers and promises to grow worse as younger deferred men are drafted, it is noted.

NEW ENGLAND

The textile industry in New England anticipates an unusually active post-war market for cotton and woolen goods and plans for extensive changes and additions to its equipment. According to one prominent textile official, machinery manufacturers will be busy for three years after the conclusion of war in filling the needs of mills in the machinery line, a forecast that carries much encouragement for sales of motors, lighting and control equipment. The highway and street lighting outlook is optimistic in view of the large amount of both state and municipal planning for improvements of traffic lanes.

Airports and landing fields are among the projects planned by the Northeast Airlines in its post-war schedule for bringing air transportation to over 400 communities in New England. A $157,986 addition to the Chelsea, Mass. Naval Hospital, which will require supplies for new lighting, will be constructed by N. S. Kelliher, Boston, and housing for officers at New London, which involves light and power extensions will be built by A. F. Peaslee, Hartford, Conn. The Bureau of Yards & Docks has awarded contracts for installation of fire protection systems at a Massachusetts air field and an ammunition magazine.

Sales of electrical equipment are dragging in this area as compared with 1944 but an unusually large portion of the Naval expenditures bill affecting New England and awaiting action presages improvement in the market. Among the requirements featured on Navy schedules bid by New England manufacturers, were insulating materials, transformers from 5 kva to 37.5 kva., heating elements, radio accessories, and small motor-driven bench tools.

NEW YORK

War spending during the first half of April was greater than during the first half of March when war costs hit a monthly peak, the Treasury reported. During the first 15 days of this month, war expenditures totaled $4 billion compared with $3.8 billion in the first half of March. Production in the industrial field is being maintained on a high level, although manpower shortages are causing pinches in some areas.

The sharp declines in the output of electricity in the weeks ended April 8 and April 15, as reported by the Edison Electric Institute, have brought the index back to August, 1943, levels. Living costs in United States in March held at the February level, according to the National Industrial Conference Board, whose combined index stood at 103.4 for the two months. This was 0.4 percent higher than March, 1943.

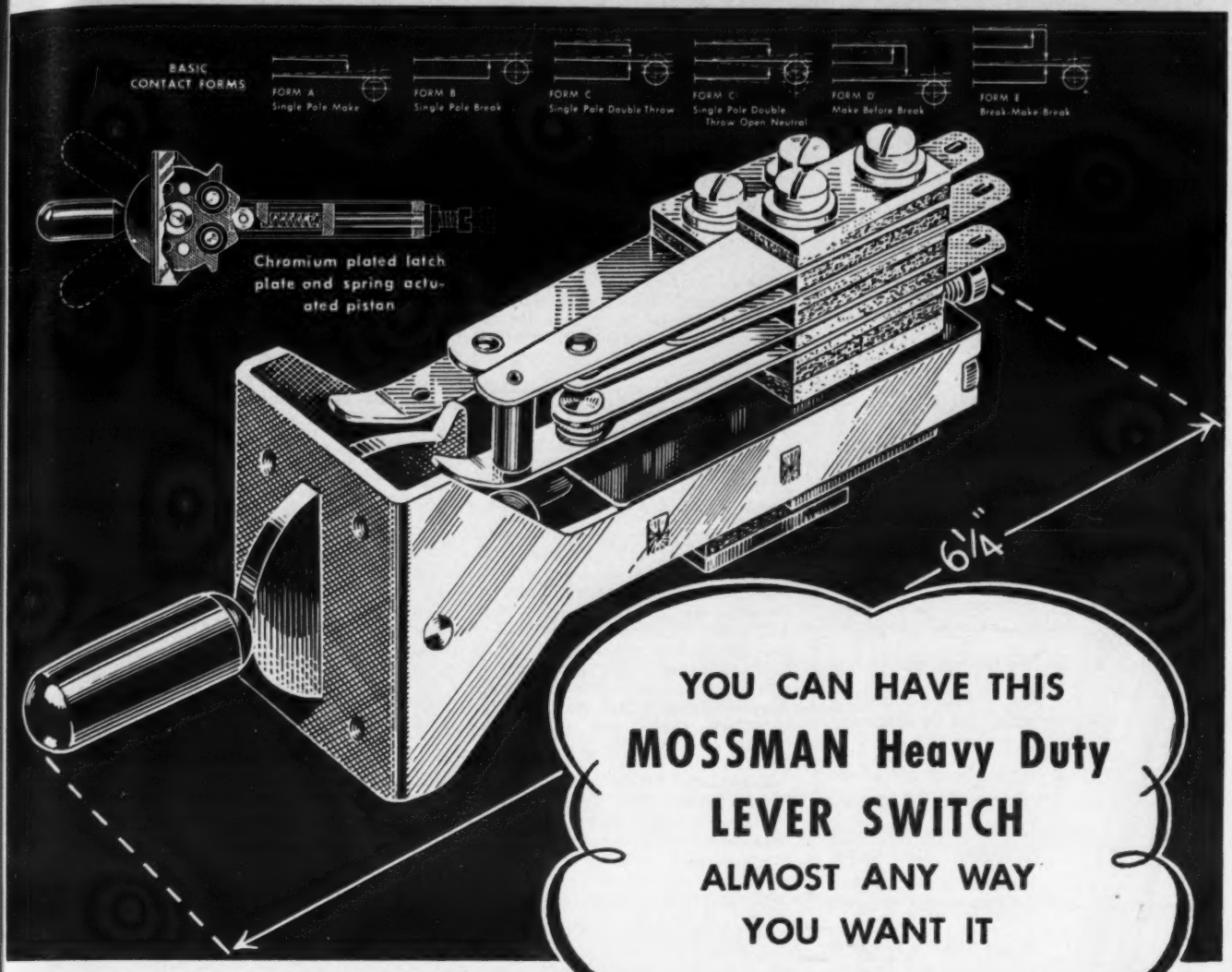
Civil engineering construction volume in continental U. S. totaled $51,425,000 last week. This volume was 56 percent higher than in the preceding week, but 38 percent lower than in the corresponding 1943 week as reported to *Engineering News-Record*. Private construction topped the preceding week by 115 percent, and was 120 percent above last year. Public construction gained 49 percent over the preceding week, but was 45 percent under a year ago as a result of the decrease in federal work. The week's construction brought 1944 volume to $568,425,000 for the sixteen weeks of the period, a decrease of 51.5 percent from the $1,171,009,000 in 1943.

PACIFIC COAST

Pacific Coast sales of metal molding and kindred lines and their fittings are increasing because of much reconversion work, especially from the many buildings being remodeled as government departmental offices with their large number of outlets for telephones, heaters, and the like. Total building permits for the seven western states increased markedly during March, 1944 over March, 1943.

A recent award of $2,974,000 for expanded facilities and naval receiving barracks for Camp Parks in East Bay area carried an electrical sub-contract of about $120,000. From 3 to 4% of the total is the typical percentage for the electrical installation in such construction.

Orders include $95,000 of cable for maritime ships in a south San Francisco yard; a $25,000 group of 5 to 250 hp. motors for an oil refinery; and 600 fractional horsepower motors for calculating machines. A million dollar shortware transmitting station to cover the entire Pacific theatre of operations will be erected and operated by Columbia Broadcasting System in California for OWI. Pacific Gas & Electric Co. reports that 62,503 dwelling units have been built in its territory in northern and central California since Pearl Harbor, with 21,250 additional scheduled for 1944 construction.


BASIC CONTACT FORMS
FORM A Single Pole Make
FORM B Single Pole Break
FORM C Single Pole Double Throw
FORM C Single Pole Double Throw Open Neutral
FORM D Make Before Break
FORM E Break-Make-Break
Chromium plated latch plate and spring actuated piston
6¼"

YOU CAN HAVE THIS MOSSMAN Heavy Duty LEVER SWITCH ALMOST ANY WAY YOU WANT IT

If your requirements call for a Heavy Duty Lever Switch with up to 48 springs . . . use the Mossman 4101 Switch. You can have it with as many as your circumstances demand. There is nothing stereotyped about this heavy duty switch except the quality.

Any combination of the six basic contact forms shown here are available in order that this versatile switch shall most exactly meet your needs. Inverted forms may also be provided to save space.

Standard heavy duty contacts give the Mossman 4101 Heavy Duty Lever Switch a rating of 10 amperes, 110 volts A.C. (non-inductive). These are of 3/16" diameter fine silver. For higher rating, extra heavy duty contacts of 5/16" diameter, silver alloy, permit use of 20 amperes, 110 volts A.C. (non-inductive).

But when it comes to high grade, precise construction of quality materials, the Mossman 4101 Heavy Duty Lever Switch permits of no deviation. Here are some of the construction features that make this switch popular in the utility field:

FRAME: Heavy brass, rigidly braced.

LATCH PLATE: Chromium plated, with stops set in to effect lock, non-locking or no-throw positions.

PISTON: Stainless steel, spring actuated, with roller mounted clevis fashion.

CONTACTS: Spun into plated phosphor bronze springs. Ample wiping action assures clean surfaces, rapid liberation of heat, longer life.

INSULATION: Spring pile-up insulators are Bakelite wafers assembled under pressure to insure against distortion. Breakdown rating—2000 volts A.C.

The Mossman 4101 Heavy Duty Lever Switch is built to give positive action at all times without regard to vibration or shock. The positive action is reliable and independent of the pressure of the contact springs.

Send for new catalog for complete description of the 4101 Lever Switch and the many other Mossman precision electrical components. These include many types of heavy duty multiple circuit lever switches, turn switches, push switches, plug jacks and special switching components.

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To Help Good Workmen Make Strong, Permanent Connections

These Sherman Splicing Sleeves give your workmen the finest of material with which to make strong, permanent, corrosion-free joints of highest conductivity.

A highly dependable line of sleeves, widely used throughout the electric utility trade. Each sleeve stamped for easy identification. Carefully packed.

Standardize on Sherman Sleeves. It pays!

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Write—

For catalog illustrating the full line of Sherman Electrical Specialties and giving complete specifications.

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Sales Opportunities

OREGON—Mountain States Power Co., Albany, plans extensions in transmission lines. Permission has been secured and work will begin soon.

WISCONSIN—State National Guard, office of Adjutant General, Capital Building, Madison, has plans maturing for new power plant at institution at Waupaca, estimated to cost over $250,000, with equipment. Application will be made soon for a priority rating. Battey & Childs, 231 South LaSalle St., Chicago, Ill., are consulting engineers.

VERMONT—Jones & Lamson Machine Co., Springfield, manufacturer of machine tools, will carry out expansion in plant for production for government, including machinery and electrical equipment. Cost about $385,000, with financing by Defense Plant Corp. Work is scheduled to begin soon.

CALIFORNIA—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensions in naval station, including shops, warehouses and other buildings, with mechanical and electrical equipment. Also will make additions in electrical distribution system and power substation facilities. Cost estimated close to $400,000. Project will be carried out under direction of Commanding Officer, 11th Naval District, Public Works Office, foot of Broadway, San Diego.

MARYLAND—Bethlehem-Fairfield Shipyard, Inc., Fairfield, near Baltimore, an interest of Shipbuilding Division, Bethlehem Steel Co., Baltimore, plans new power substation at yard, with installation of transformers, switchgear and auxiliary equipment. Project has a priority rating.

ALABAMA—Opelika Mills, Inc., Opelika, has plans maturing for large one and multi-story addition to cotton mills, estimated to cost about $1,000,000, with machinery and electrical equipment. Extensions will be made in power substation, with installation of additional equipment. Bids will be asked soon for general erection. It is understood that project has a priority rating. Robert & Co., Bona Allen Bldg., Atlanta, Ga., are architects and engineers.

WASHINGTON—Owens-Illinois Glass Co., Pacific Coast Division, 135 Stockton St., San Francisco, Calif., manufacturer of glass bottles, plans new plant, tract of about 35 acres of land has been acquired, to be carried out as a post-war project. It will comprise group of about 14 connected buildings, one, two and three-story, estimated to cost approximately $3,500,000, with machinery and electrical equipment. A power plant is planned. Also administration building, laboratory and miscellaneous units. Austin Co., Ray Bldg., Oakland, Calif., and 16112 Euclid Ave., Cleveland, Ohio, is architect and engineer.

MICHIGAN—Ford Motor Co., Dearborn, has approved plans for new power plant for works service and construction will be placed under way at once. No estimate of cost announced.

LOUISIANA—Water Department, Natchitoches, plans installation of motor-driven pumping machinery, with controls and auxiliary equipment in connection with extensions in water system for increased source of supply. Entire program is estimated to cost about $140,000. Application will be made soon for a priority rating.

OREGON—Department of Public Works, City Hall, has plans under way for installation of new ornamental lighting system on North Wabash Ave. Work will be carried out as soon as materials and equipment are available. Benjamin S. Morrow is city engineer, in charge.

OREGON—Northwestern Ice & Cold Storage Co., 73 S. E. Washington St., Portland, has contracted with government for construction and operation of new ice-manufacturing and freezing plant for federal service. Structure will be multi-story type, with machinery and electrical equipment for large capacity. Cost estimated about $700,000, with financing by Defense Plant Corp. Work is scheduled to proceed at once.

KANSAS—Beech Aircraft Corp., Wichita, has plans maturing for new one-story addition, reported to cost over $300,000, with machinery and electrical equipment. Erection contract will be awarded soon. Project has a priority rating.

WASHINGTON—Department of Lighting, Seattle, will award contracts soon for structural work in connection with proposed extensions in power substation, including galvanized structural steel for a five-bay addition to 26-kv. bus and switch racks, disconnecting switch supports for 220-kv. switch units, four 220-kv. pedestal bus insulator supports, and other miscellaneous steel structures. Project is estimated to cost about $850,000, with transformers, switchgear and accessory equipment, including extensions in transmission lines in immediate vicinity. Project has a priority rating.

MISSOURI—Water Department, Kansas City, is considering report submitted by Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, consulting engineer, for proposed extensions in water system, including new booster station, with motor-driven pumping units, controls and auxiliary equipment. Cost estimated about $100,000. Entire project as recommended will approximate $1,900,000.

CALIFORNIA—American Can Co., 111 Sutter St., San Francisco, has plans under way for five one-story additions to branch plant, totaling over 65,000 sq. ft. floor space. Cost reported in excess of $300,000, with mechanical and electrical equipment. Application is being made for a priority rating. Company engineering department, first noted address, is in charge. Main offices are at 230 Park Ave., New York, N. Y.

LOUISIANA—Light and Water Department, Opelousas, has approved plans for addition to municipal power plant and will award contract for erection at early date. Additional equipment will be installed for increased output. No estimate of cost announced. It is understood that project will have a priority rating.

PENNSYLVANIA—McCreary Tire & Rubber Co., Indiana, will carry out expansion in mill for manufacture of tires from synthetic rubber for government, including additional building, with machinery and electrical equipment. Cost estimated about $200,000. Financing by Defense Plant Corp. Work will begin soon.

IDAHO—Navy Department, Washington, D. C., has plans under way for extensions in naval training station, including additional buildings, with electrical and mechanical equipment, to cost about $500,000.

REA Announces New Allotments

The Rural Electrification Administration recently announced allotments totaling $1,101,500 to 17 rural co-operatives in 13 states. These funds, which will be used chiefly to extend electric service to farms which can substantially contribute to the food production program, bring total REA allotments to $484,445,051, of which $18,482,138 represents operations during the current fiscal year.

No construction will be undertaken which does not have the prior approval of the War Production Board.

Included are the following allotments:

COLORADO—Morgan County Rural Electric Assn., Fort Morgan, $100,000.

GEORGIA—Cobb County Rural Electric Membership Corp., Marietta, $25,000.

KANSAS—The Pioneer Co-operative Assn., Inc., Ulysses, $255,000.

KENTUCKY—West Kentucky Rural Electric Co-operative Corp., Mayfield, $50,000.

MICHIGAN—O & A Electric Co-operative, Newaygo, $50,000.

MISSISSIPPI—Coahoma Electric Power Assn., Clarksdale, $20,000; Singing River Electric Power Assn., Lucedale, $50,000.

NEW JERSEY—Tri-County Rural Electric Co., Inc., Freehold, $31,500.

NEW YORK—Delaware County Electric Co-operative, Inc., Delhi, $135,000.

NORTH CAROLINA—Brunswick Electric Membership Corp., Shallotte, $30,000; Surry-Yadkin Electric Membership Corp., Dobson, $25,000.

OKLAHOMA—Southwest Rural Electric Assn., Inc., Tipton, $100,000; Kiwash Electric Co-operative, Inc., Cordell, $120,000.

OREGON—Central Electric Co-operative, Inc., Redmond, $10,000.

TEXAS—Wood County Electric Co-operative, Inc., Quitman, $40,000; Midwest Electric Co-operative, Inc., Roby, $50,000.

WASHINGTON—Lincoln Electric Co-operative, Inc., Davenport, $10,000.

Governor Signs Arizona Power Authority Bill

Although he protested to the last moment that the measure was "inadequate and in need of changes," Gov. Sidney P. Osborn of Arizona has signed the Power Authority Act passed recently by the second special session of the 16th Legislature of his state (ELECTRICAL WORLD, March 25, page 10).

Governor Osborn pointed out that while the measure falls far short of meeting all of the state's requirements, it will enable towns, cities, irrigation, electrical agricultural improvement and co-operative organizations of the state to obtain a stable source of electric power at an economic rate.

The first Arizona municipality to take advantage of provisions of the measure was the city of Tucson, which, on the day the bill was signed, filed an application for 25,000 kw-hr. of electric power.

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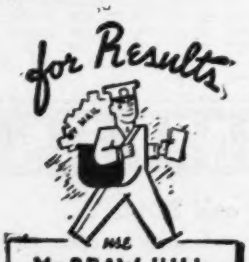

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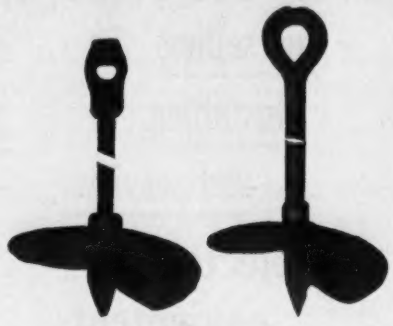
Recent Rate Cases

STATEN ISLAND EDISON CORP. is putting into effect an order issued last May by the New York Public Service Commission, directing it to reduce its rates by $230,000 a year. The order, effective Aug. 1, 1943, was issued on a temporary basis pending conclusion of a general proceeding which is still in progress. The utility challenged the order in litigation which culminated recently with a Court of Appeals decision affirming a Supreme Court decision dismissing the company's complaint. In addition to complying with the order, the commission announced that the company must refund to consumers $180,000, the difference between the rates ordered and the amount collected from consumers since last August.

NEW YORK PUBLIC SERVICE COMMISSION has approved a plan recommended by Commissioner Maurice C. Burritt for the fixation of rates for street lighting service to be charged by the Niagara, Lockport & Ontario Power Co. in its western division. The plan may affect 94 villages and towns over a large area in the western part of the state, including Erie, Orleans, Allegany, Chautauqua, Niagara, Cattaraugus, Monroe, Genesee, Livingston and Wyoming counties. The principal feature of the plan is that the utility may file a general tariff for all municipalities involved and if the rates meet with the approval of the commission, it will be permitted to become effective. This will obviate the necessity of determining street lighting rates for each municipality individually and will result in a greater uniformity of costs for such service than under the present individual agreements between the utility and the municipalities. The company has already indicated willingness to file a contract applicable to all municipalities in its territory.

CINCINNATI GAS & ELECTRIC CO. in advertisements inserted in local newspapers has declined the proposal of the city public utilities committee that the utility make substantial rate reductions in new rate ordinances, which the council committee claimed could be offset by a corresponding reduction in the special war taxes now being paid by the company. The present rate ordinances for electric and gas services in Cincinnati expire on May 31. In its advertisement the utility company said: "The power and right of the federal government to levy and collect extremely heavy taxes during war periods cannot be questioned. The company has no option other than to pay the taxes which are levied for war purposes, however burdensome such taxes may be. The obligation to pay such taxes toward the cost of the nation's war effort is inescapable. Surely this is no time for our company or the people of Cincinnati to seek to escape the payment of taxes of this kind. . . . The total business of the company increased 37.9 percent in 1943 as compared with 1939, while its taxes increased 171 percent. The company has borne this heavy tax burden without any increase in its rates. Without the collection of these taxes, paid indirectly for the company's customers, the burden of the increased tax needs of the government would inevitable be shifted to the general public . . ."

NEW JERSEY POWER & LIGHT CO. has accepted the rate adjustment plan formulated by the State Board of Public Utility Commissioners (ELECTRICAL WORLD, March 11, page 6). The board has announced that customers of the utility would receive a 50 percent billing credit on one month's bills "on and after April 1." The total saving to customers in north and central Jersey counties will amount to $120,000, the board added.



Matthews Scrulix Anchors shown above were first put on the market in 1900. The one on the left is put down with a wrench. The one on the right is screwed down by putting a bar through the eye. The one shown at the bottom of this column is for use in swampy places and is put down with standard 1½ or 2-inch pipe.

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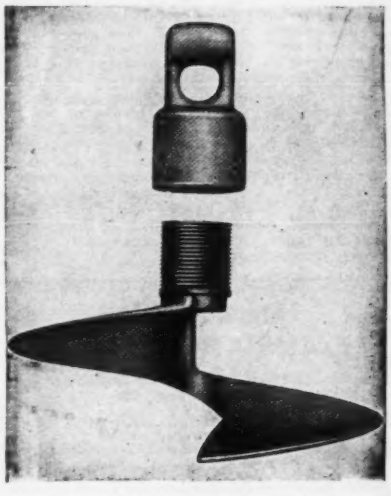

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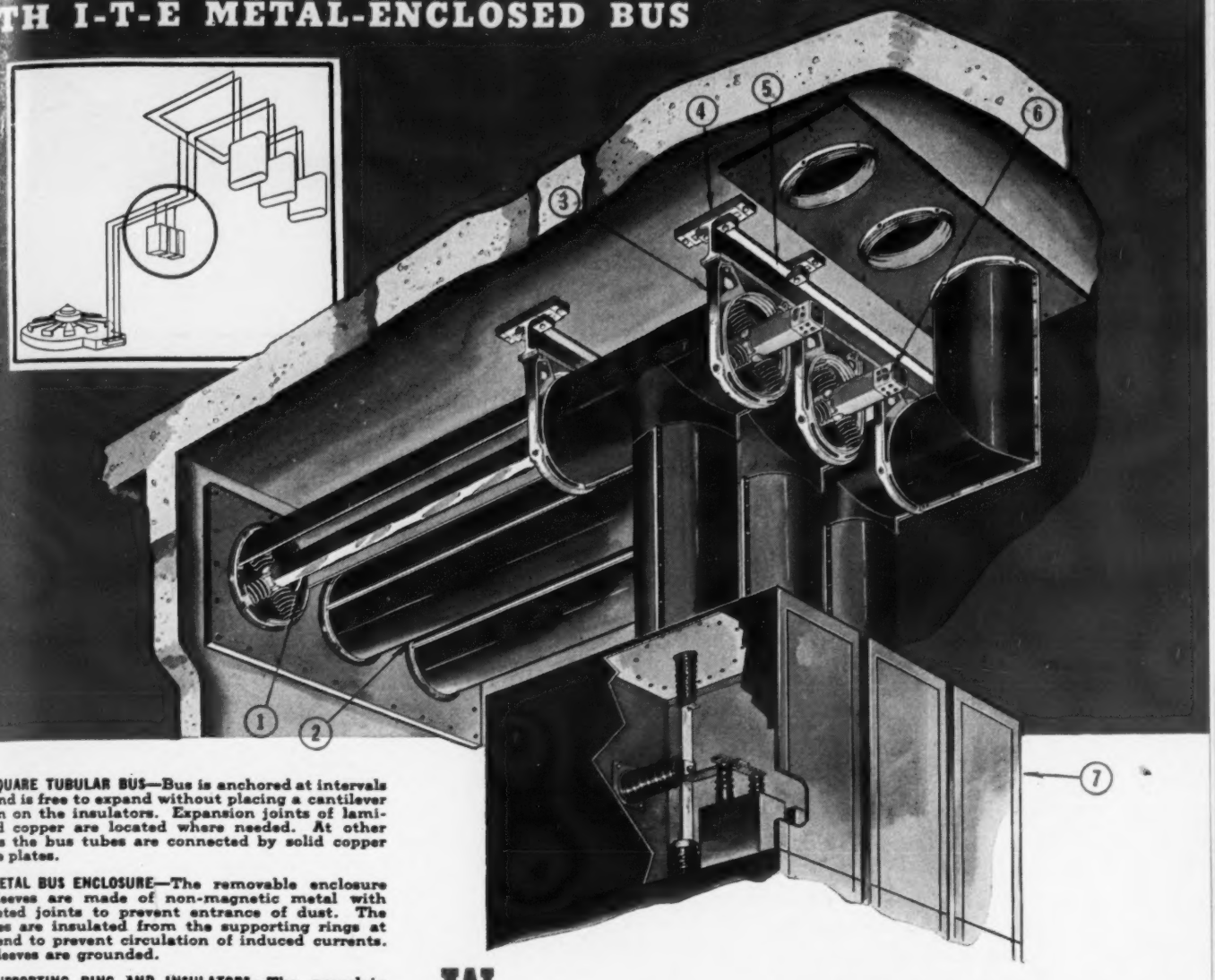
Readers tell us they read the advertising pages as much as the editorial. And for good reason! A good advertisement, like a good editorial article, brings you useful, worthwhile information in the form you want it. That's why it pays to look through the ads in Electrical World carefully.

★ **These companies have supplied additional buying information on their products in the 1944 edition of the Electrical Buyers' Reference**

PLAN NOW TO *Protect the Heart* OF YOUR SYSTEM

WITH I-T-E METAL-ENCLOSED BUS



1 SQUARE TUBULAR BUS—Bus is anchored at intervals and is free to expand without placing a cantilever strain on the insulators. Expansion joints of laminated copper are located where needed. At other joints the bus tubes are connected by solid copper splice plates.

2 METAL BUS ENCLOSURE—The removable enclosure sleeves are made of non-magnetic metal with gasketed joints to prevent entrance of dust. The sleeves are insulated from the supporting rings at one end to prevent circulation of induced currents. All sleeves are grounded.

3 SUPPORTING RING AND INSULATORS—The porcelain insulators are in compression and are free from cantilever strain because the bus can move longitudinally. Insulation is equal to that of connected apparatus. Each insulator is mounted in a ball and socket support to prevent any stresses except compression.

4 SUPPORTING BRACKET—These brackets have slotted bolt holes in serrated bearing pads to allow accurate alignment of the bus during erection. Mounting bolts are grouted in the masonry. Installation is easy because of the accessible design of the whole structure.

5 GROUND BUS—The ground bus is amply proportioned and bolted to the supporting brackets. The enclosing sleeves fit machined surfaces in the supporting rings when the sleeve clamping bolts are drawn up tight.

6 SILVER-SURFACED BUS JOINT—All bus joints are silver-surfaced to give low voltage drop and permanent freedom from overheating. At elbows like this the buses are joined with laminated copper expansion connectors.

7 POTENTIAL TRANSFORMER COMPARTMENT—The advantage of isolated-phase construction extends to these potential transformer compartments. Steel cells with dust-excluding gaskets give full protection. Short circuits cannot extend from phase to phase.

Whether conditions call for segregated-phase construction, as in the example illustrated, or a simple arrangement of conductors, electrical buses should be planned in the interest of life-long dependability and economy. With I-T-E such planning is an established business which starts with design and carries through complete assembly. I-T-E engineers have pioneered major improvements to provide structures that operate within specified temperature limits, are adequate electrically and mechanically and cause minimum voltage drop.

A detailed summary of the problems to be considered in planning is presented in a 24-page, illustrated booklet, "Electrical Buses and Bus Structures", written by William Deans, I-T-E Chief Engineer. It is Bulletin 4211, and a few copies are on hand.

A three-phase metal enclosed bus is shown because it is typical of thoroughly modern structures. The small diagram indicates position between generator and transformers.

Representatives in Principal Cities

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR — ENCASED IN STEEL

ARMY E NAVY

This Army-Navy "E" for Production Excellence

CIRCUIT BREAKER CO., PHILADELPHIA 30, PA.

What do you want to know about Turbine Oil?

Recently a number of utility plant men were asked, "What do you want to know about turbine oil?" Several of them had very specific questions. They are answered here because they may help you in selecting a turbine oil that solves, once and for all, the ever present problem of turbine oil maintenance. One question is taken up each month, but you can get the answers to all of them now—see the booklet offer.

2. What causes acidity increase in turbine oil?

Acidity in turbine oil, like asphaltene formation, is caused by oxidation—brought about by the close mixture of oil with air. The higher the temperature, the more rapid the oxidation.

Unlike the asphaltene formation, acidity is not so easily eliminated or controlled. Asphaltene-formers can be removed by refining, whereas all of the acid-forming parts of the oil cannot. Acidity formation in turbine oil is objectionable because the acids, although very weak, slowly attack certain metals forming metal soaps. Both the acids and the soaps are strong emulsifiers, so that high acidity always means a poor rate of separation from water—poor demulsibility. As the concentration of these metallic soaps increases, some of them no longer remain soluble in oil, but deposit in cooler parts of the system. These deposits are part of the sludge which forms when conventional oils are used.

Turbine oils having acidities equivalent to about 0.3 mg.KOH/gm. tend to show only a fair rate of separation from water. When acidities approach 0.8, the emulsion test is usually poor, and many operators change oil or treat it to reduce acidity.

The problem was solved in Nonpareil Turbine Oil by removing all of the asphaltenes through refining even though this removes the natural inhibitors. An oxidation inhibitor is added that more than compensates for this loss and completely controls acidity formation. Proof of the effectiveness of this inhibitor is a written guarantee given with Nonpareil that it will not increase in acidity over the extremely low limit of 0.15 mg. KOH/gm. Operating records show that acidity seldom exceeds 0.05 in Nonpareil Turbine Oil. On top of that the same turbines are entirely free from asphaltene deposits.

It should be noted that the increase in acidity of turbine oil during operation, rather than the acidity of the new oil, is the important factor.

The function of the inhibitor used in Nonpareil Turbine Oil and how it controls acidity will be discussed in this space next month.

Oil is Ammunition . . . Use it Wisely

For all the answers send for this booklet...it contains answers to questions such as these:

1. What causes turbine oil deposits or sludge?
2. What causes acidity increase in turbine oil?
3. What is an oxidation inhibitor—how does it prevent acidity?
4. How does a guaranteed turbine oil protect the user?
5. Does the inhibitor in Nonpareil Turbine Oil wear out?
6. What causes corrosion in turbines?

Send for a copy of this booklet, or better still, ask for a Standard Lubrication Engineer. He can answer your specific questions about Nonpareil Turbine Oil. Write Standard Oil Company (Indiana), Room 1223, 910 S. Michigan Ave., Chicago 80, Ill., for a copy of the booklet, or the Engineer nearest you.

NONPAREIL TURBINE OIL

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